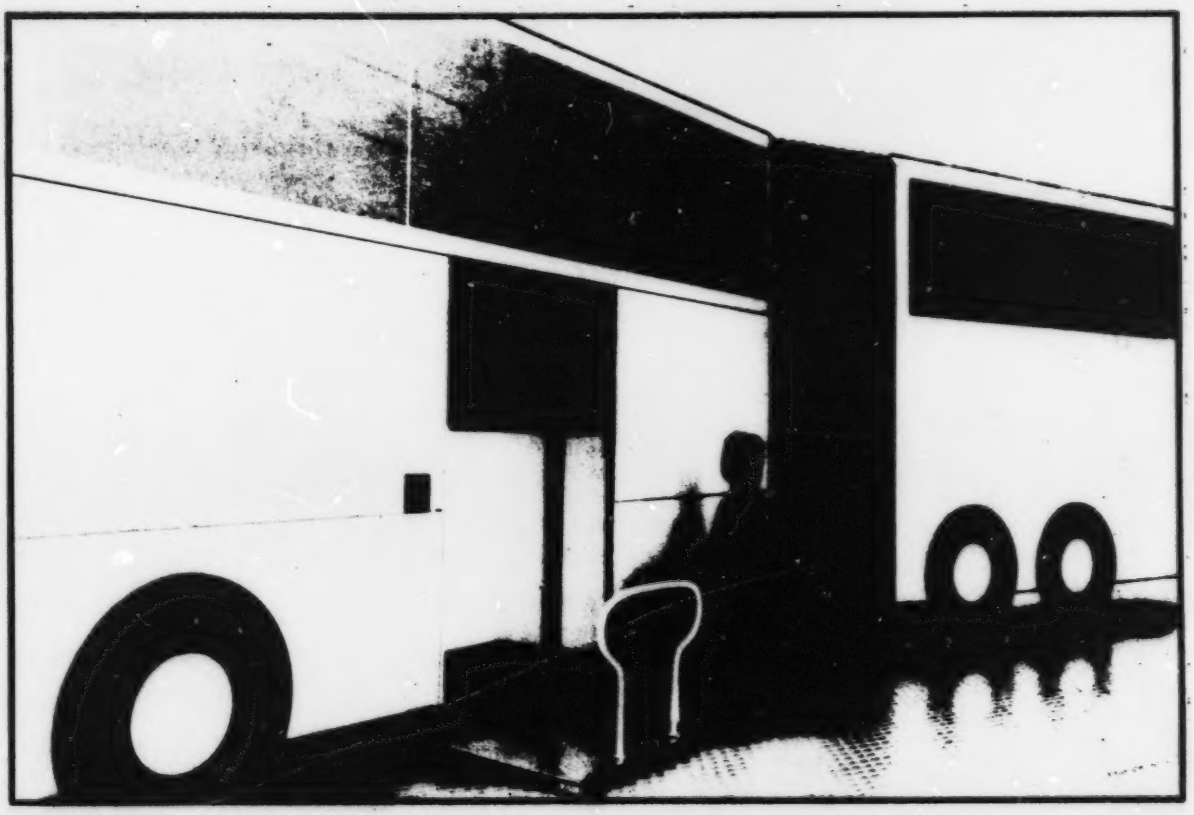
TP 4403 E

Design Concept for Access of Special Need Travellers on an Articulated Bus



Prepared for
Transport Canada
Transportation Development Centre

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ost Car Inc. &
Designers Douglas Ball Inc.

February 1983

TP 4403E

DESIGN CONCEPT FOR ACCESS OF SPECIAL NEED TRAVELLERS TO AN ARTICULATED BUS

Designed by

Prevost Car Inc.
Sainte-Claire, Dorchester, Quebec
and
Les Designers Douglass Ball Inc.
Sainte-Anne-de-Bellevue, Quebec

Prepared for

The Transportation Development Centre
Transport Canada

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17. Abstract

This report is the result of a feasibility study of proposed designs which allow access to an articulated intercity bus by special need travellers. These travellers in particular, are wheelchair users and the semi-ambulatory. The articulated bus is now under development by Prévost Car Inc.

The main elements of the final design concept are: an internal elevator - the platform of which extends horizontally at either curb or road level to provide access for the wheelchair user; a wheelchair tie-down (securement) - a located behind the elevator to immobilize the wheelchair and provide support for the passenger; a washroom - immediately in front of the elevator, which is accessible from the wheelchair; and a privacy screen which unfolds automatically to enclose the wheelchair passenger when using the washroom.

The novel aspects of this concept are the boarding of wheelchair and semi-ambulatory passenger by an elevator, without being exposed to the public or to weather, and the distance between tie-down and washroom shortened.

Full size mock-ups of washroom layouts and securement spaces were constructed to test and demonstrate minimum requirements for the wheelchair passenger.

A scale model of the complete bus was fabricated to show all elements of the design concept and the alternative seating and wheelchair positions.

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17. Résumé

Ce rapport rend compte des travaux d'une étude sur les diverses options pour l'adaptation d'un autobus articulé aux voyageurs ayant des besoins spéciaux; il s'agit notamment des personnes en fauteuil roulant et de celles à mobilité réduite. L'autobus articulé, fait actuellement l'objet d'un projet de développement par le constructeur Prévost Inc.

Le concept définitif est caractérisé par: un élévateur embarqué sortant horizontalement jusqu'au niveau du trottoir ou du sol; un dispositif d'ancrage disposé derrière l'élévateur, immobilisant le fauteuil roulant ainsi que son occupant; une toilette placée juste devant l'élévateur et aisément accessible et enfin un écran qui se déplie automatiquement lorsque la toilette est occupée.

Les innovations du concept sont le système d'embarquement par un élévateur, protégeant complètement l'utilisateur contre les intempéries et les regards indiscrets, et la toilette exclusive à courte distance du poste d'immobilisation.

Des maquettes en vraie grandeur des aménagements de toilette et d'immobilisation ont été construite afin de déterminer l'espace minimum requis par les personnes en fauteuil roulant.

Enfin, une maquette à l'échelle de l'autobus a été construite montrant les divers éléments du concept ainsi que les dispositions possibles des sièges et du fauteuil roulant.

18. Mots-clés	19. Diffusion
Autobus articulé. Handicappé physiques. Voyageurs ayant des besoins spéciaux. Accessibilité. Elévateurs de fauteuil roulant.	Le CDT dispose d'un nombre limité d'exemplaires.

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- Component Design Drawing (Concept C)
- Concept Analyses

1. INTRODUCTION

A request for proposal was issued by Prévost Car Inc. as part of a development program for the Transportation Development Centre to study the accessibility of wheelchair users and other special need travellers to board and ride an articulated bus designed by Prévost Car Inc.

The contract for this study was awarded to Douglas Ball Inc., in September of 1982.

Accessibility was defined in the proposal as being of particular importance to the special need traveller when long distance (inter-city) travel is involved.

The design criteria of this problem, as related to those travellers with specific requirements, were to take into account accessibility to the transport mode, manoeuvering space within the vehicle (especially for the wheelchair user), appropriate seating space and comfort, securement for wheelchair and passenger, and proper access to the washroom.

This report is the developmental study and design of articulated bus accessibility as approached by Douglas Ball Inc.. It includes an analysis of technical and human factors (ergonomics) concerning accessibility for the special need travellers.

The main objectives of this study have been to research, develop, establish criteria and provide a final design concept for:

- A means of dignified access for the wheelchair user and other special need travellers.

- Space arrangements for such passengers with consideration to comfort, security and position of wheelchair. Seating arrangements are also considered.

- An accessible washroom for all passengers (using minimum assistance).

One of the criteria involved in meeting the above objectives was to minimize seat loss and costly structural changes in bus construction for the manufacturer.

Fig. 1 Buses are difficult to board for the person in a wheelchair.

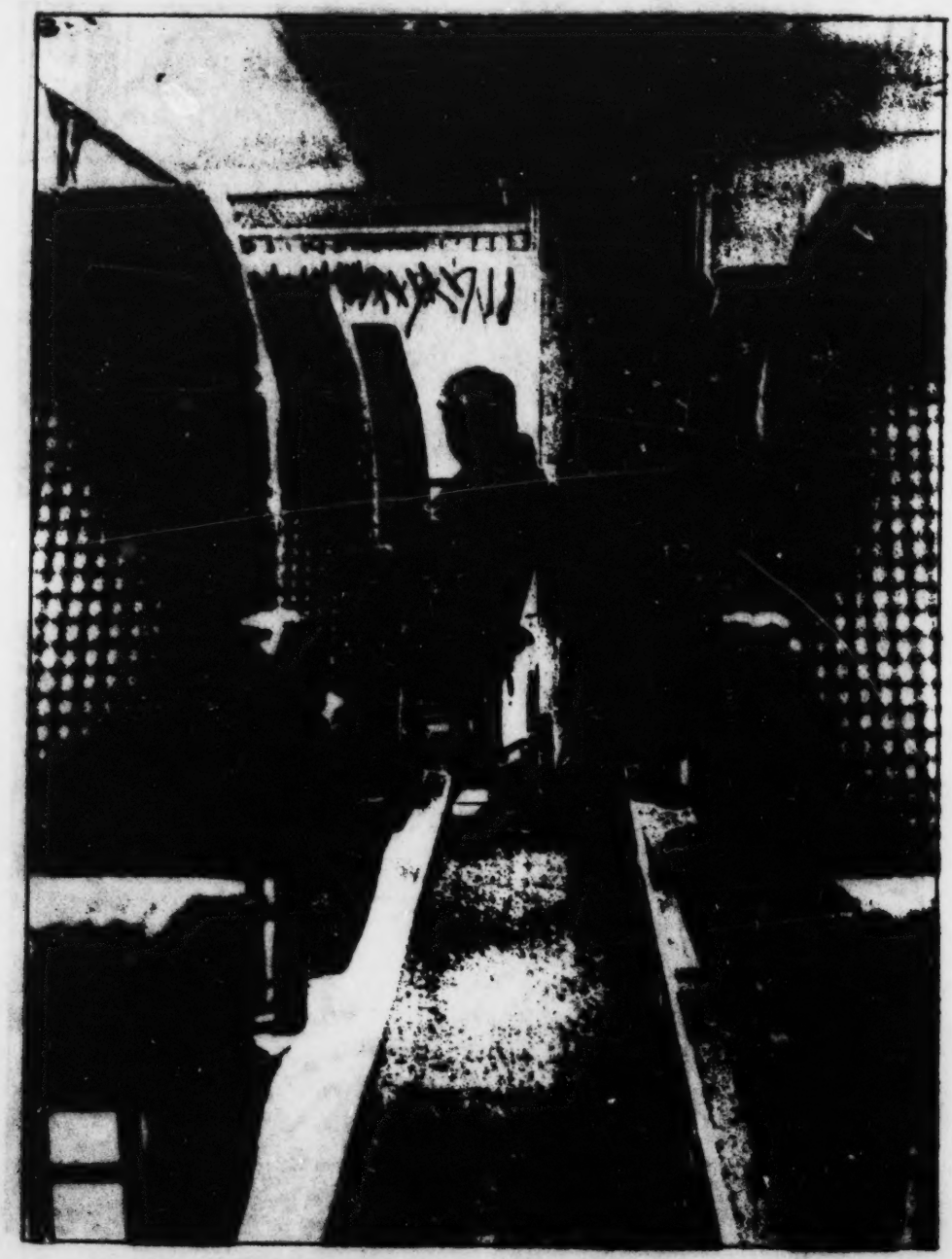


Fig. 2 Manoeuvering space for a wheelchair is not provided on long-distance buses. Aisles too narrow.

2. CRITERIA

2.1 General

No definitive standards can be found that relate specifically to the requirements for manoeuvering space; doorway size; washroom design, fixtures, comfort, support and hygiene aids, for use on inter-city buses particularly for use by special need passengers.

Standards that compare in some respect to the space requirements of the inter-city bus are those developed for the airline industry by the Aerospace Industries of America, Inc.. These standards are limited as a reference because only "on board" wheelchairs (e.g. narrow aisle chairs and other special toilet chairs) are discussed and these have a maximum open width of 458 mm (18").

Washrooms on airlines, so far, have not been designed for use by passengers in conventional wheelchairs. Existing washrooms have only been "adapted" for the special need group. An "aid kit" is usually provided to overcome difficulties with such fixtures as water taps and call buttons. One development in this area, which is worth considering, is the use of "privacy curtaining", which is drawn across the aisle to isolate the passenger during transfer to the standard washroom from his "on board" wheelchair.

The floor height of buses is generally so great that two or three steps have to be mounted. Some European models, e.g. the "city bus" from Steyr-Daimler - Push AG in Vienna, have a lower floor height, as do certain buses used at airports for transport of passengers between planes and terminal buildings. Even these buses have one or two steps, however. The same applies to buses (which have been subjected to limited tests) with bodies that can be lowered at bus stops. An example of one of these is the "kneeling bus" developed by Grumman and now in operation in the U.S.A.

Since the eventual occupants of the Prévost bus will be travelling through normal intercity traffic situations, they should be provided with a degree of safety equal, given the opportunity, to that provided to any passenger travelling the same road in an automobile. Obviously, this dictates the use of personal restraint systems similar to those found in automobiles. Thus, lap and shoulder belts, or their equivalents, should be provided.

A headrest should be provided for comfort and support, and it should curve under the back of the head to take some weight, and possibly around the sides as well. The position must be adjustable to accommodate the wide variety of heights and postures of wheelchair users. Body restraint and support may be provided by shoulder and lap belts, or pads supported by the wheelchair itself, or externally. It is important to note that passengers may not feel comfortable although well supported and secured. The key here is not only to supply what is necessary to give the user a feeling of comfort and security, but also to ensure that all potential users' needs are provided for as the range of disability is quite broad.

2.2 Criteria for the elevator

Through investigation the height of entry and exit steps seems to be the dimension that has the most effect on current bus usage. This is due to the fact that the elderly and the semi-ambulatory have difficulty in climbing steps. The wheelchair user has no means of boarding such a bus while seated in a wheelchair. To help solve this problem elevating systems have been developed by several manufacturers. Lift platforms that project out from the bus and suspend the traveller in an exposed way, high off the ground, cantilever fashion, are not acceptable psychologically, nor are they practical in engineering terms because of the vertical distance involved. The safety aspects of most of these systems have not been fully tested under the harsh climatic conditions as found in Canada. Even if such a lift were designed for the articulated bus, storage of the platform would pose difficulties. The internal projection of such an elevating device would prevent a high standard of interior finish and would prove to have a visually disturbing effect. This arrangement would also partially block out light for passengers in the rear section.

One solution to this problem for example, entails equipping long distance buses with a built-in elevator, often at the back. This system has been tested in Belgium using a Volvo chassis. During the journey the elevator platform constitutes part of the floor of the bus.

An example of small internal lift adjacent to rear entrance of European long distance bus is shown on the following page, Fig. 3.

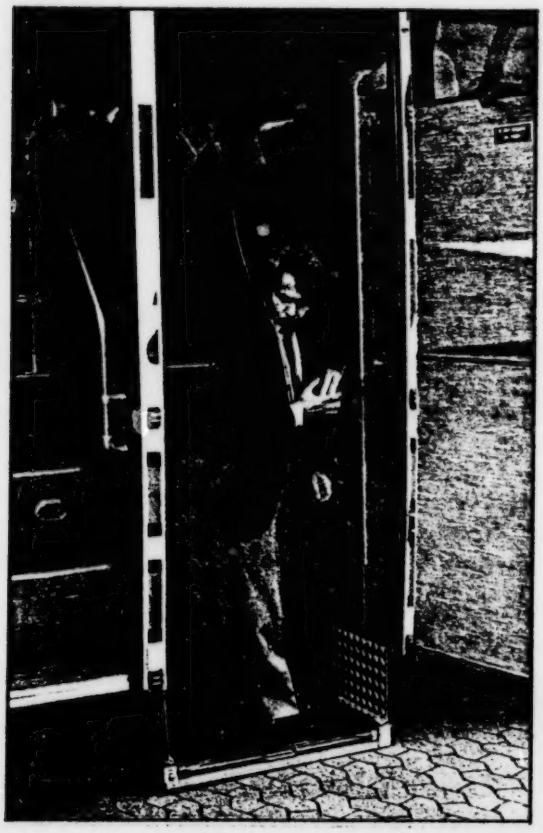


Fig. 3 Small internal elevator, suitable for semi-ambulatory, as found on some European intercity buses.

This final approach of an internal lift is a practical one for the Prévost articulated bus, but the rear position is not a suitable one, for i) the designated length of the bus, ii) the severe winter conditions, iii) the position of the disabled "to the rear" of the bus might be psychologically harmful, and v) the fact that accessibility to the lifting device in this position might be hampered by parked vehicles, and other factors connected with road transport.

This elevating concept is most suitable for application to the articulated bus design and the rear/curb side position was decided after consultation with Prévost when it was found that front location position meant that the washroom (located at the back) would not be accessible. An accessible elevator door behind the wheel on the curb side prevented use of rear doorway and steps, as required for safety reasons, and the wheel arch structure left too little room for an elevating mechanism and structural reinforcement.

It is easier to provide the necessary safety arrangements in a built-in elevating system than one mounted outside the vehicle. The disadvantages of the built-in systems are, of course, the time factor, and the fact that the lift occupies valuable space in the bus. The time factor and to some extent the space factor are not so important in connection with long distance buses and charter buses as they are for buses in city traffic. The suitability of this type of elevating device in the articulated bus is evident when the total number (72) of passenger is considered. With the proposed elevating system boarding/deboarding of ambulatory passengers can be achieved through the front and rear door at the same time the semi-ambulatory and wheelchair passengers are using the suggested built-in lifting device.

Location limitations and required space determined the elevator platform position just inside a main structural member. The size was established at 800 mm wide x 1150 mm deep projecting to the centre line of the bus.

The size was determined by the dimensions of three (3) sizes of wheelchairs, including the electric wheelchair the use of which is becoming more prevalent.

These wheelchairs range in overall width of between 610 mm and 710 mm and the elevator should accommodate the new electric wheelchair, which has a width of 760 mm.

On the following pages are illustrations of some of the elevating devices investigated.

Fig. 4 Electro-hydraulic step lift.
(Transi-Lift Equipment Corp.)

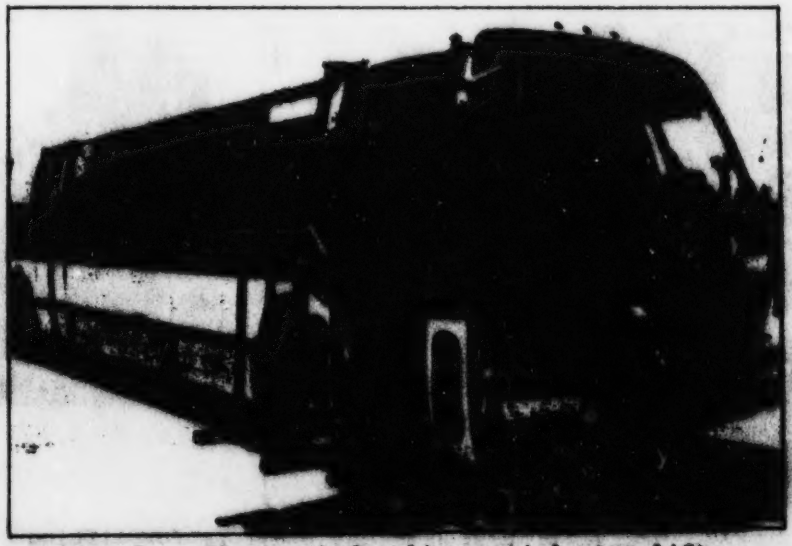


Fig. 5 Electro-hydraulic partial step lift.
(Lift-U-Inc.)

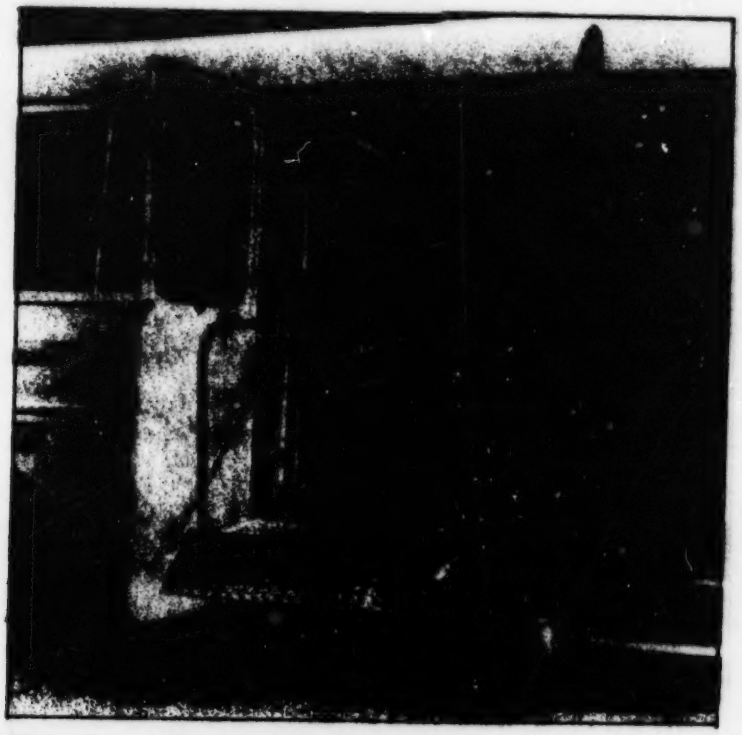


Fig. 6 Electro-hydraulic platform.
(Coach & Equipment Manufacturing Corp.)

Fig. 7&8 Autobus with mobile platform for lifting wheelchairs.
(Milan Municipality)

2.3 Criteria for the washroom

In view of the lack of adequate specifications available for washroom design for the special need passengers (as applied to inter-city buses), Douglas Ball Inc. set out to establish necessary criteria.

The premise for design was based on the dimensions of the standard wheelchair and the minimum space required for manoeuvering while seated in the chair. The rear position of the washroom, as suggested by Prévost Car Inc., was retained. It seemed appropriate to keep most of the original seating alyout, as the space had been utilized quite efficiently. The major change was to eliminate the boarding steps and rear door, and to bring the washroom floor level with the seating floor.

Through the use of a full size mock-up of the washroom, which was fabricated by Douglas Ball Inc., it was found, using a standard wheelchair, that a clear door opening of 750 mm was the required minimum. This dimension has been substantiated in a Swedish study - Adapting Public Transport for the Handicapped, a summary of the report in Swedish S04 1975: 68/p.96.

The minimum interior space required for manoeuvering a wheelchair 360° in a washroom was found, through testing, to be 1300 mm by 1500 mm (see layout, Concept A - Fig. 12). This is in fact less than the minimum standard of 1400 mm by 1500 mm required for toilet stalls in transport terminals.

Positions of hand basin and toilet fixtures were determined after considering the particular shape of the space so that adequate head clearance was maintained for a standing adult using the hand basin and a seated adult using the toilet fixture. The position for the toilet fixture was chosen to provide the greatest amount of room in front of the user, sitting diagonally to the washroom plan, and at the same time providing considerable clearance on each side. Handrails were positioned accordingly for use by all passengers.

In this proposal (Concept A) the hand basin is accessible from a wheelchair and the toilet is easily approached. Transfer can be made from four chair positions (lateral right, lateral left, front and rear). The washroom dimensions also allow room for a standing attendant when assistance is required by the non-ambulatory passenger and others.

Specific preliminary dimensions relating to the position and proportions of all washroom fixtures were researched and considered in the first layout (see Concept A, Fig. 12).

2.4 Criteria for the tie-down (wheelchair securement)

The disabled and elderly often have greater difficulty than other people in countering movements of the bus during braking or turning. This must be taken into consideration when designing the interior of buses. Immediately inside the entry door there should be a protected area intended primarily for a person in a wheelchair, the semi-ambulatory, or a parent with a baby stroller. The area should be separate from the aisle. The wheelchair passenger enters the space from the side door, via the elevator, and positions his/her wheelchair facing forward. A system restrains the wheelchair and supports the occupant; and a three-point safety belt should be provided for greater safety. A baby stroller or other item is placed in the protected area in a similar way.

Although wheelchairs are equipped with parking brakes, manoeuvering through streets, normal bus oscillations and the possibility of emergency braking make a restraint or tie-down system for the chair a necessity. The basic criterion used here is that the system must restrain the chair from any movement under the most severe acceleration or deceleration of which the bus is normally capable. The system must be easily operated. It must accommodate the wide variety of wheelchair dimensions and frame details which occur.

The system should not require more maintenance than any other item in the bus. It should also blend in with the rest of the bus in terms of color, aesthetics, and not add to the "medical" look of a wheelchair.

Douglas Ball Inc. has developed a wheelchair securement system (Multimodal Wheelchair Securement/Passenger Restraint Prototype Development TP 3057E by Uwe Rutenberg, Douglas Ball Inc., for Transportation Development Centre, Transport Canada, May 1981). This system, after having been thoroughly tested under simulated crash conditions, is the state-of-the-art in wheelchair securement devices as applied to transit buses.

Although not an automatic device, it is simple to use by the passenger who has ability to use his arms and hands. In this respect it would be advantageous for the passenger unable to secure himself to have the assistance of a companion or attendant. (See illustration on following page).

The policy which should be adopted by all inter-city bus carriers should be similar to that of VIA Rail who have the two for one fare, whereby the special need traveller who is unable to assist himself is welcome to travel with a companion, for no additional fare.

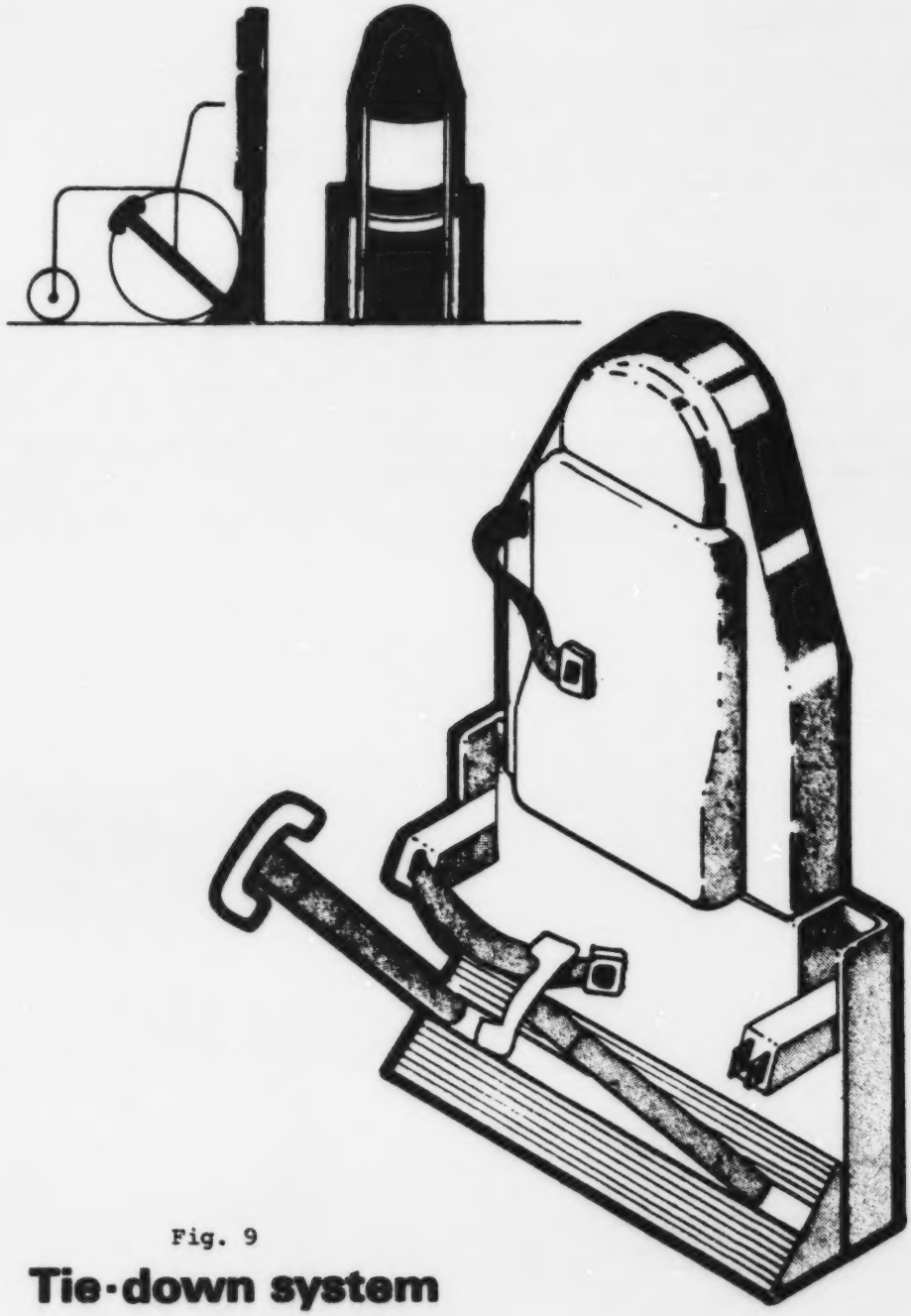


Fig. 9

Tie-down system

(suggested design only - to be developed further for use on articulated bus)

3. DESIGN CONCEPTS FOR ARTICULATED BUS ACCESSIBILITY

3.1 Concept A

The first full size mock-up of the rear section of the articulated bus was useful in helping to establish the minimum space requirements of the wheelchair user in the washroom and the position of fittings as appropriate to the seated disabled, the semi-ambulatory, and the elderly passenger (see Fig. 13 to 18).

Various wheelchair positions and alternative seating layouts based on this concept were suggested. These layouts have been presented in a simple form for clarity. They show wheelchair positions for one, two and the maximum number of wheelchairs (8) that can be accommodated when applying the design of the washroom as suggested in the rear position, and providing an elevator for the wheelchair passenger. (See Fig. 12).

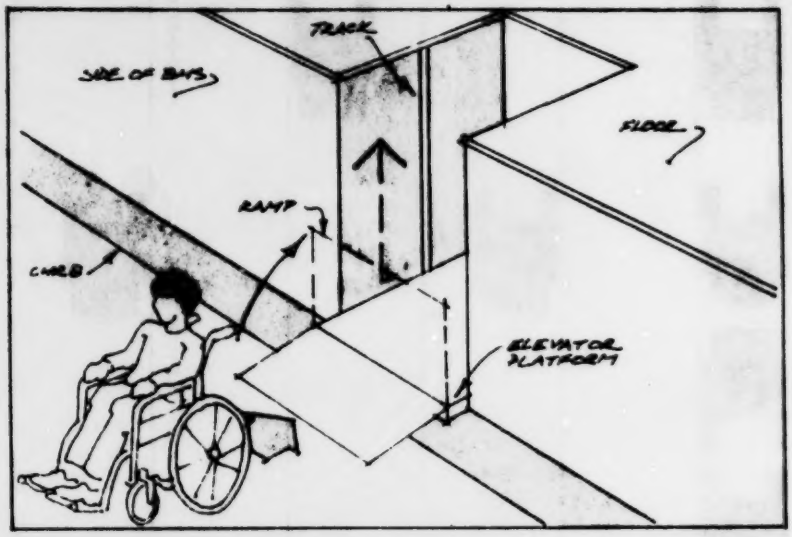


Fig. 10 Deep, vertical elevator with adjustable ramp is proposed for Concept A. Wheelchair passengers access in reverse for safety and for better visibility.

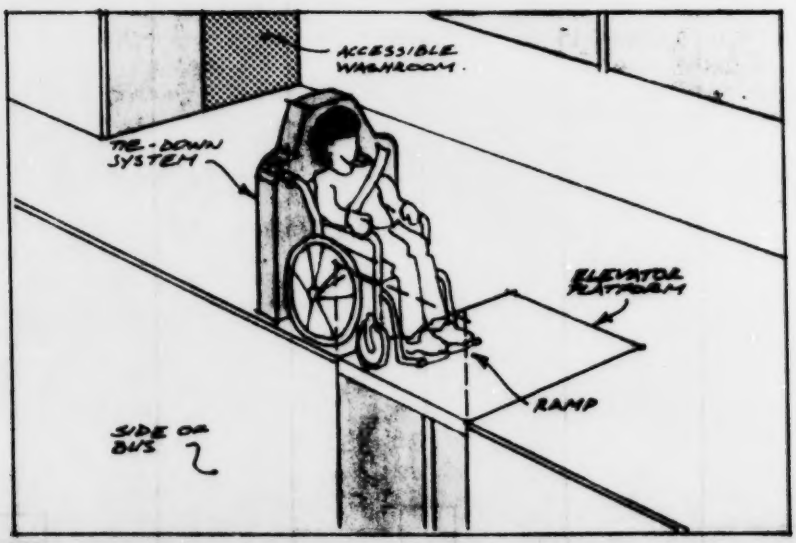
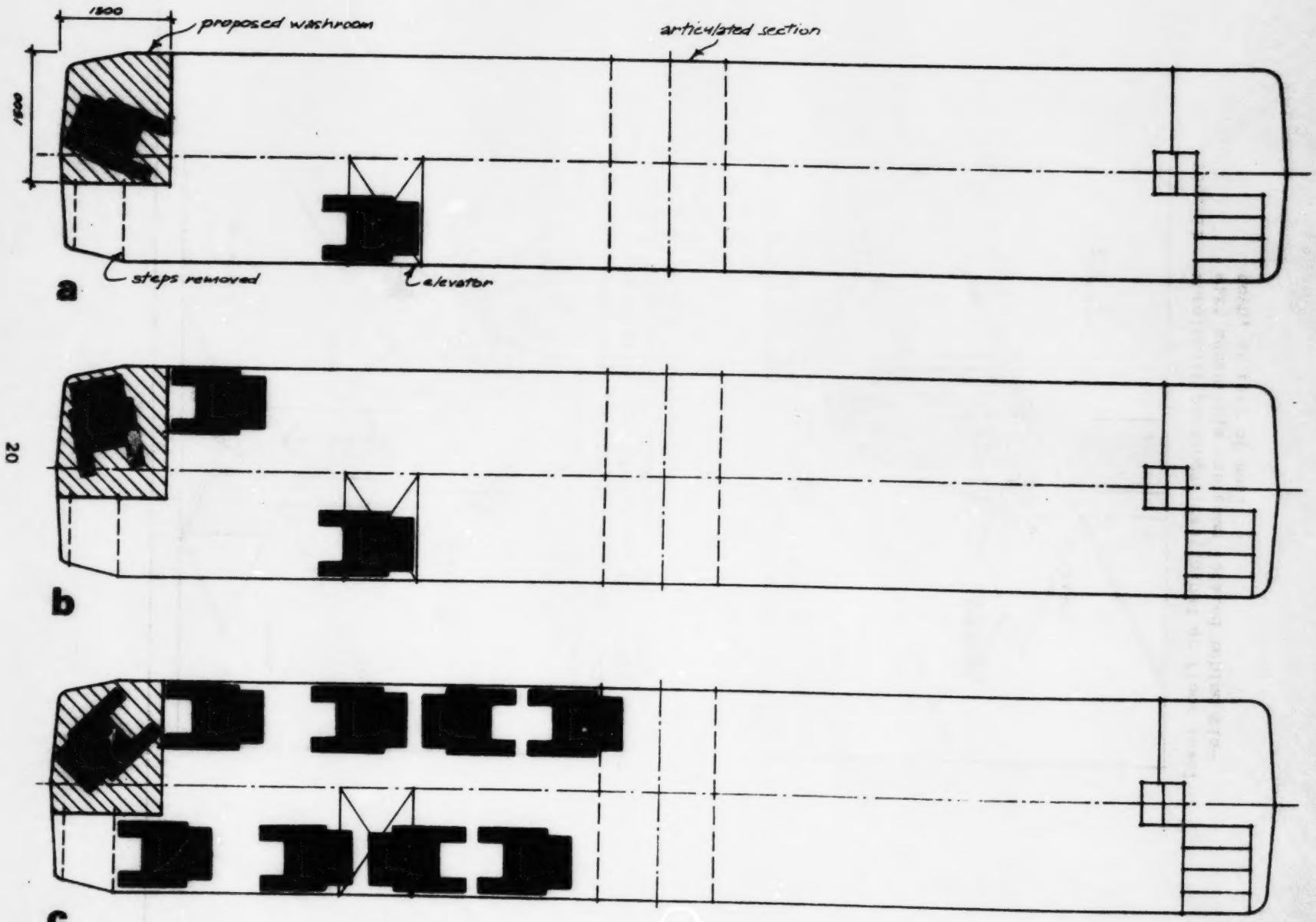


Fig. 11 Wheelchair passenger restrained at floor level with accessible washroom located behind tie-down, at rear of bus.



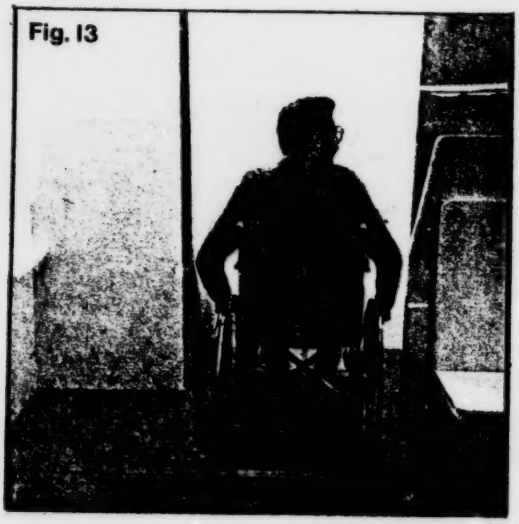
Layout Aa:
No of wheelchair spaces - 1 No of standard seats - 17
'T' represents tie-down

Fig. 12 A

Proposed Washroom - Layout 'A'
For Articulated Bus by Prévost Car Inc.

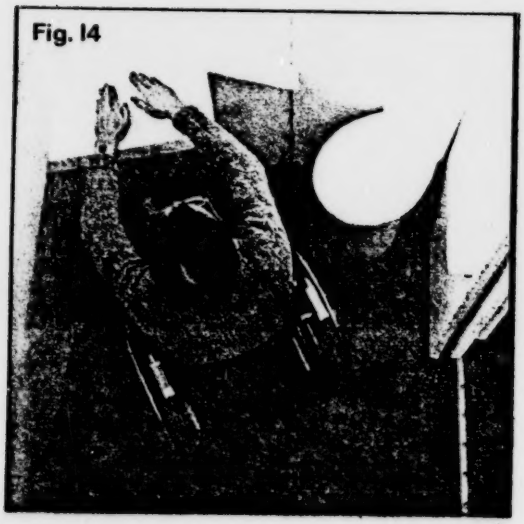
To be located in back section of articulated bus - rear right side corner. The following photos (fig. 13 to 16) show the first full size mock-up as fabricated by Douglas Ball Inc.

Fig. 13



Wheelchair user entering 750 mm wide doorway. Tie-downs shown to left and right of doorway.

Fig. 14



Inside washroom using hand basin from wheelchair position.

Fig. 15

Position for lateral transfer from wheelchair to toilet using handrails for support.

Fig. 16

Position for rear transfer to toilet through back of wheel-chair as appropriate.

Fig. 17

Opening sliding door internally from seated position.

Fig. 18

Leaving washroom to return to any one of tie-down positions.

3.2 Concept B

The second full size mock-up of the washroom shows another approach using the minimum space requirements for the wheelchair but without providing the manoeuvering space found in Concept A. This space has been minimized to allow either forward or backward access with some limited side movement.

Although there is insufficient room in this scheme to allow for an attendant within the washroom, a jump-seat has been provided to assist transfer for both wheelchair user and semi-ambulatory passengers.

This particular arrangement is shown in simplified form in layout sheet B - Fig. 21.

As can be seen, as many as seven wheelchairs can be accommodated. The need for manoeuvering space has been reduced considerably for the single wheelchair in layout Ba. The elevator has been retained in the same position as found in Concept A, as shown in Fig. 12.

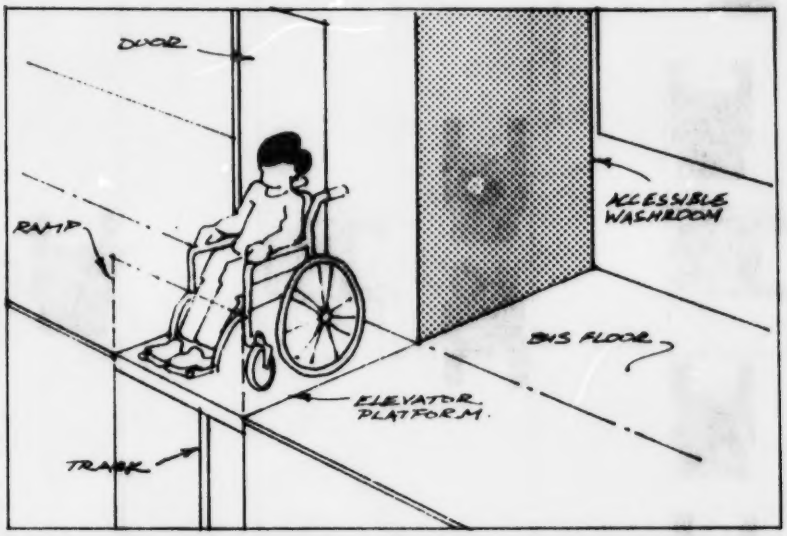


Fig. 19 Wheelchair passenger in position after boarding bus via elevator. The passenger must manoeuver, assisted or unassisted, to the tie-down position, as shown in Fig. 20.

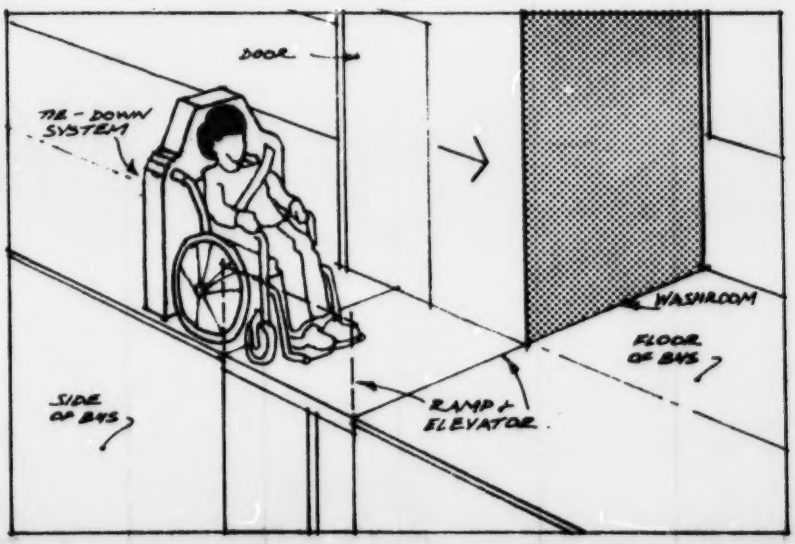
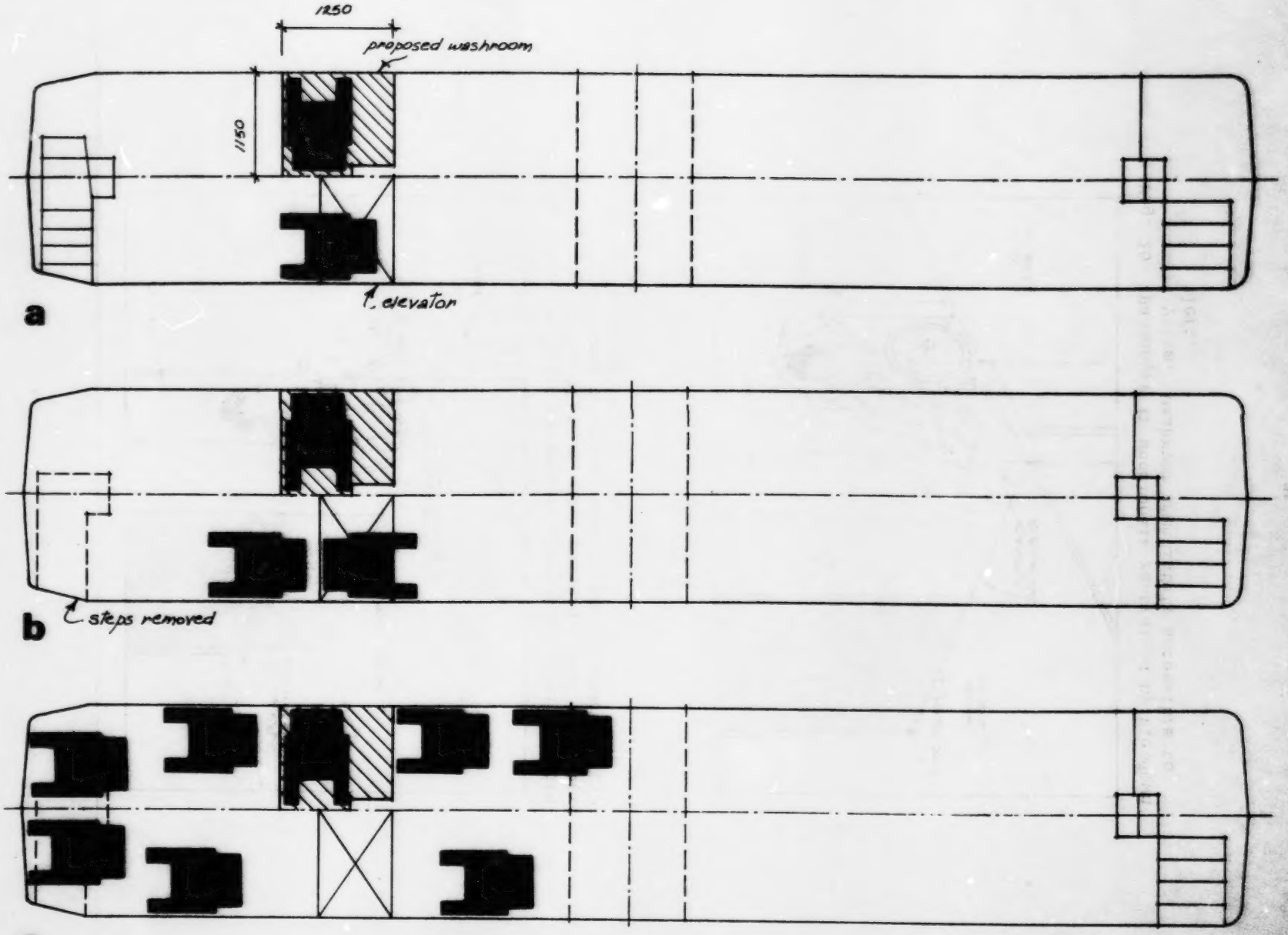


Fig. 20 Passenger in wheelchair restrained by tie-down system. Washroom immediately accessible to left.



Layout Ba:
No of wheelchair spaces - 1 No of standard seats - 21
'T' represents tie-down

Fig. 21

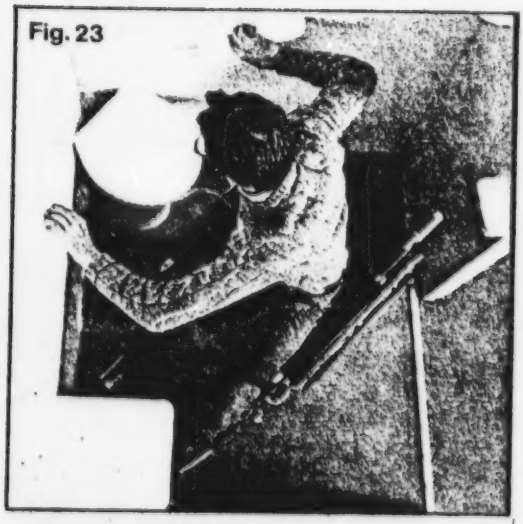
Proposed Washroom - Layout 'B'
For Articulated Bus by Prévost Car Inc.

To be located in back section of articulated bus - middle position approximately, to right of centre line and opposite wheelchair lift. The following photos (Fig. 22 to 27) show the second full size mock-up as fabricated by Douglas Ball Inc.

Fig. 22

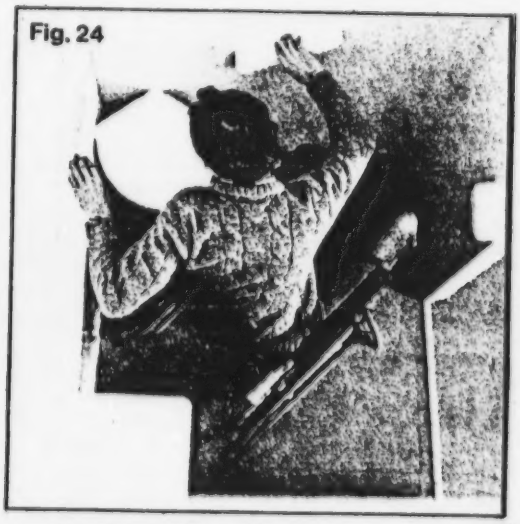
Inside washroom using hand basin from wheelchair position.

Fig. 23



Position for (right) lateral transfer from wheelchair to toilet using handrails for support.

Fig. 24



Position for (left) lateral transfer from wheelchair to toilet.

Fig. 25

Releasing tie-down in preparation to manoeuvre to washroom.

Fig. 26

Entering washroom through 750 mm doorway opening.

Fig. 27

Returning to tie-down position.

3.3 Concept C

This concept was put into the scale model of the bus as it seemed to fulfill most of the needs of the passenger, the operator and the manufacturer. The elevator position was also formulated after comments from Prévost regarding the impracticality of the position as shown in Concepts A and B (Fig. 12 and 21 respectively). In order to avoid major structural modifications to the basic bus, the alternative position (elevator length running parallel with bus, resolving problem of cutting into structure), as shown in Concept C - Fig. 30, was suggested. To take advantage of the new arrangement, and to do so without increasing the length of the elevator (which would mean taking up premium floor space), a "drawer-slide" principal for the elevator platform was introduced. This would eliminate any unnecessary manoeuvering of the wheelchair in accessing the elevator. This also meant that the passenger in the wheelchair would wheel or be assisted onto the platform, which could rest directly on the road or sidewalk, parallel with the side of the bus. Once on the platform, facing toward the front of the bus, he/she would then be moved with the platform (in a sideway position), automatically or manually by the operator, into the body of the bus. The passenger would then be enclosed on three sides in a physically and psychologically secure way, ready to rise vertically to the floor of the bus.

Once level with the floor, and if being the only wheelchair passenger, he/she would (if able) back into the tie-down located immediately behind the elevator platform.

Directly in front of the passenger is the washroom of a compact but efficient design. Access is forward of the wheelchair passenger with no manoeuvering required if the disabled passenger is able to support himself/herself with the continuous handrail, on the right side. The side door consists of a folded screen which, when released, unfolds automatically to provide side access to the washroom. Another screen, situated behind the tie-down encloses the passenger in the wheelchair, the elevator platform and the tie-down, giving complete privacy to the person in the transfer space.

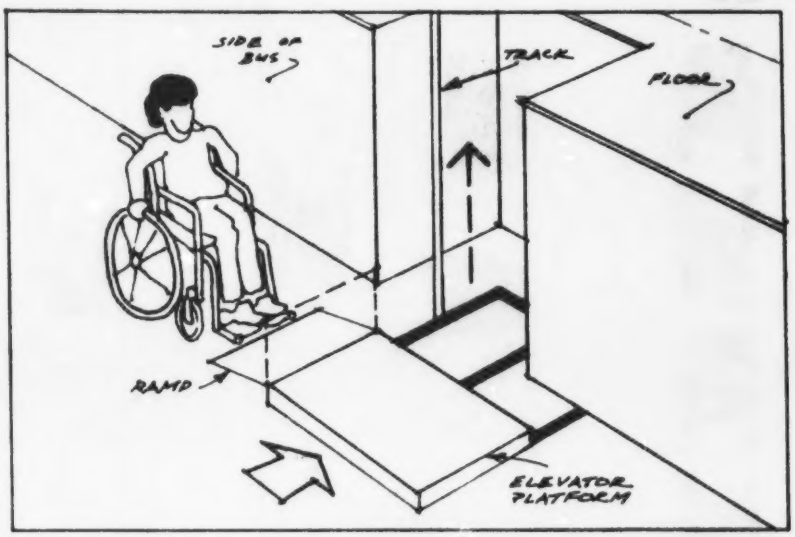


Fig. 28 Revised concept showing elevator platform turned 90° to run parallel with side of bus. Platform surface extends to clear bus structure. Wheelchair passenger accesses forward from side (refer to isometric drawing, Fig. 31).

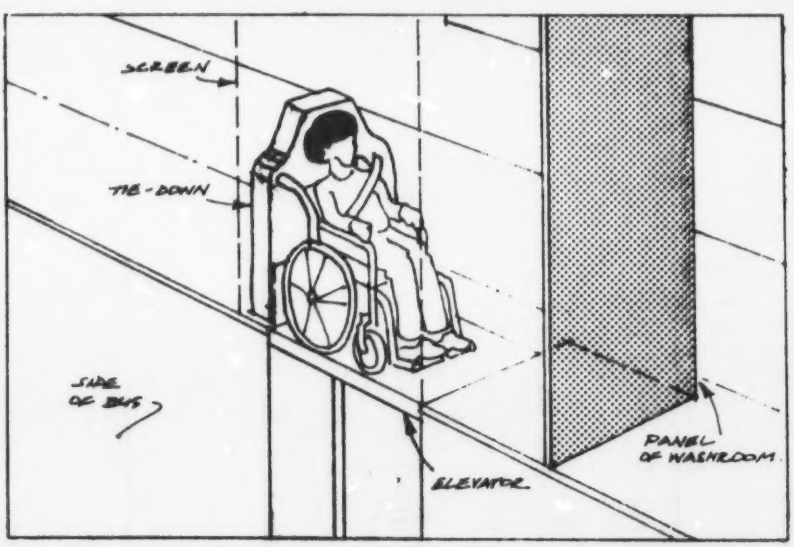
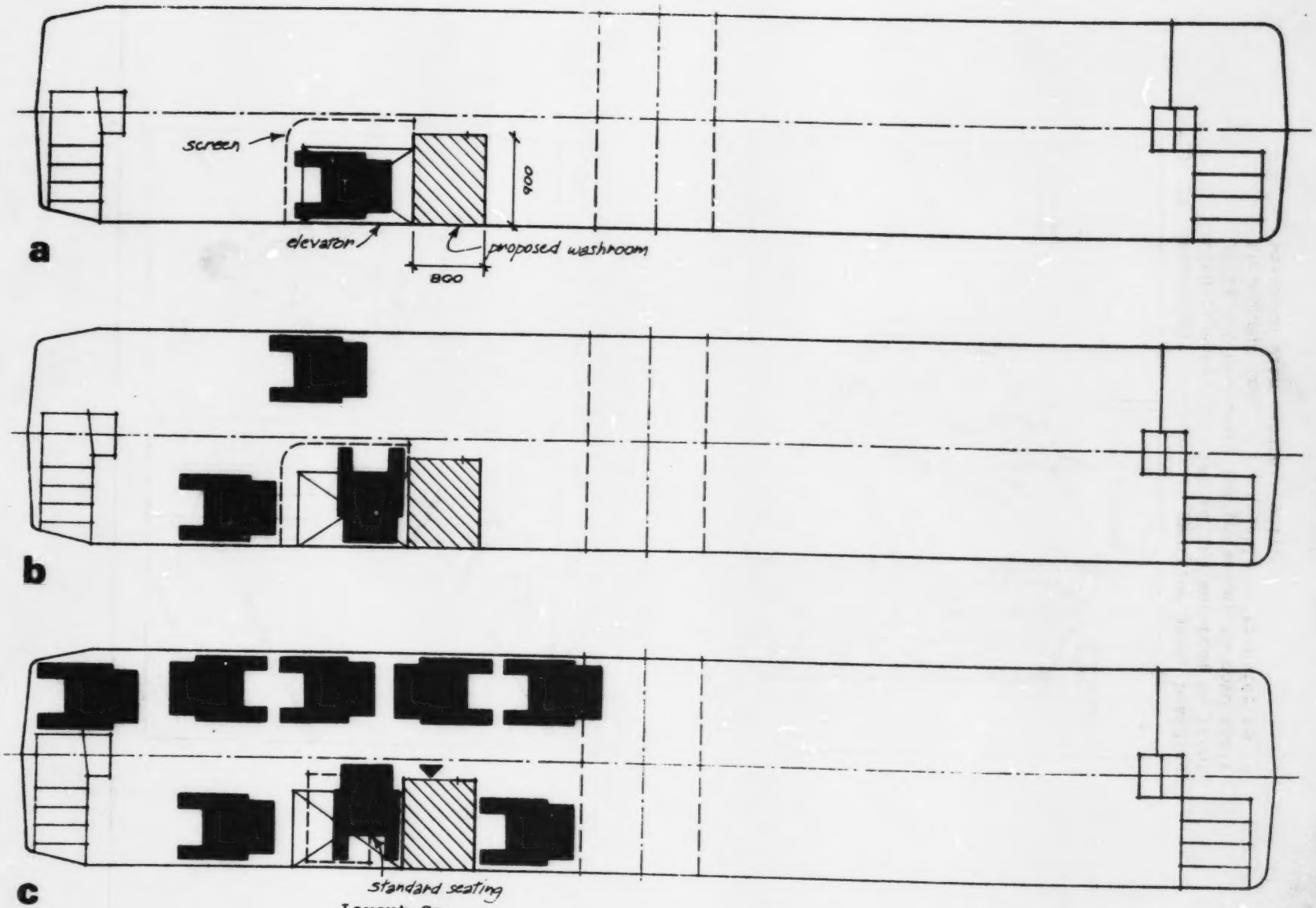


Fig. 29 Wheelchair passenger in position after boarding with tie-down just behind and washroom to front. It is not necessary for passenger to move chair throughout trip if he is able to transfer to washroom with handrail only.



Layout Ca:
No of wheelchair spaces - 1 No of standard seats - 20 3/4
'T' represents tie-down

Fig. 30 C

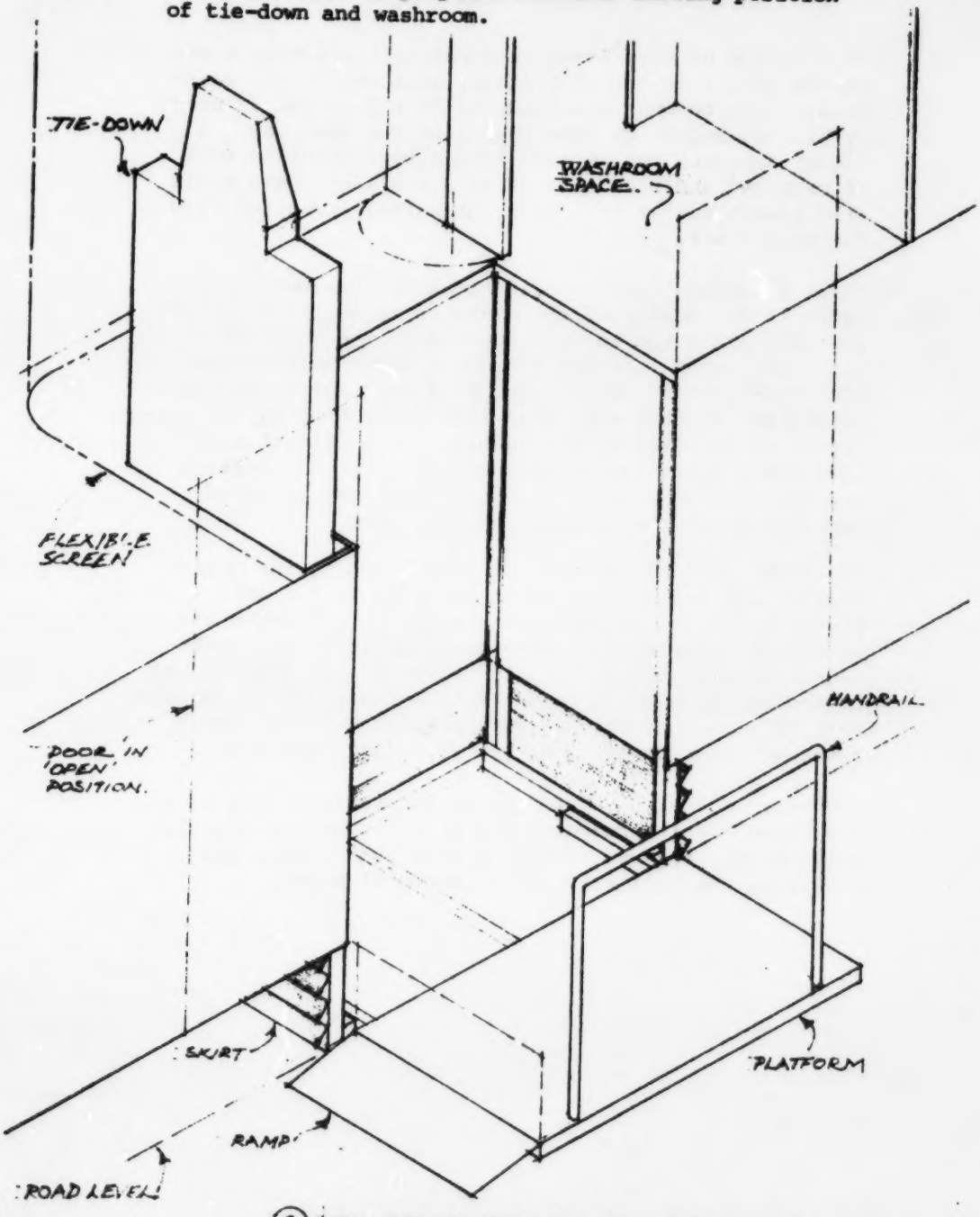
In the case of more than one wheelchair position taken on the bus, this transfer space, adjacent to the washroom, which becomes enclosed, is left free and is used by all passengers in wheelchairs in the same way. A closer approach can be made from either front or back if required and the depth of this transfer space would also permit either left or right lateral transfer from the wheelchair.

It is intended that a hinged transfer seat be incorporated in the design of the washroom to assist transfer. The handrail would be continuous from the tie-down to the toilet seat back and along the front wall across the "tip-up" hand basin. There is room for an attendant behind the screen, who, when finished assisting the passenger to transfer to the washroom, can exit through the wide aisle door. It is proposed that special seating for the semi-ambulatory or others would be situated opposite or in the vicinity of this door.

The final concept (Concept C) as applied to the articulated bus design by Prévost Car Inc. is a viable solution for the special need traveller and takes all necessary requirements into consideration. The preliminary drawing (#1082/4) illustrates the proposal based on the research and mock-up testing undertaken by Douglas Ball Inc. in consultation with Prévost Car Inc. and Transportation Development Centre. (See Appendix).

A number of design and technical innovations have evolved through this project. These, although specifically intended for the use in articulated bus design, are worthy of adaptation to other transport modes.

Fig. 31 Isometric view of proposed elevator showing position of tie-down and washroom.



(2) VIEW SHOWING ELEVATOR MECHANISM FULLY LOWERED TO ROAD LEVEL. WITH PLATFORM EXTENDED 'DRAWER SLIDE' FASHION TO CLEAR BUS SKIN AND DOORS RAMP FOR WHEELCHAIR (OR OTHER ROLLING ACCESS E.G. CATERING CARTS) IS LOWERED FROM HANDRAIL POSITION. ACCESS IS FROM ONE END OF PLATFORM AS WHEELCHAIR MUST FACE FORWARD WHEN IN BUS (FL. LEVEL) SO IT CAN BE ADEQUATELY RESTRAINED WITH TIE-DOWN.

ISOMETRIC
SCALE - 1:20

3.4 Innovative Design Features

The aspects of this project which are considered to be of value to bus transportation generally and to the special need passenger in particular are:

Access: (elevator)

- dignified access by partially enclosed vertical elevator, not exposed to rest of passengers.
- elevator able to extend to road and/or curb level.
- elevator platform can be used for wheelchairs, semi-ambulatory passengers, integral jump seat, food carts, and loading/unloading of equipment.
- platform space is used as position for travelling when at floor level.

Restraint System: (tie-down)

- tie-down restrains wheelchairs of different dimensions.
- also secures passengers with a three-point belt system.
- adjustable back support.
- adjustable head support.

Washroom:

- door of washroom opens and transfer space encloses at touch of button operated by wbeelchair user.
- wide opening to washroom.
- continuous handrail leading from tie-down directly into washroom and around washroom walls.

- completely private transfer space.

- washroom can be accessed from four wheelchair positions.

- room for attendant.

- transfer seat available as part of toilet fixture.

- ergonomic toilet design.

- "tip-up" hand basin to maximize use of space.

- comfortable lever controls for wash basin and toilet fixture.

- accessible personal hygiene aids.

- extra wide aisle door for other passengers.

- resilient folding screen in front of wheelchair when tied down.

Manoeuvering Space: - shortest possible distance between all facilities (i.e. elevator, restraint and washroom).

These features are defined in more detail in the accompanying preliminary design drawing which can be found in the appendix.

Fig. 32 Model showing semi-ambulatory passenger seated on elevator platform. Attendant is assisting.

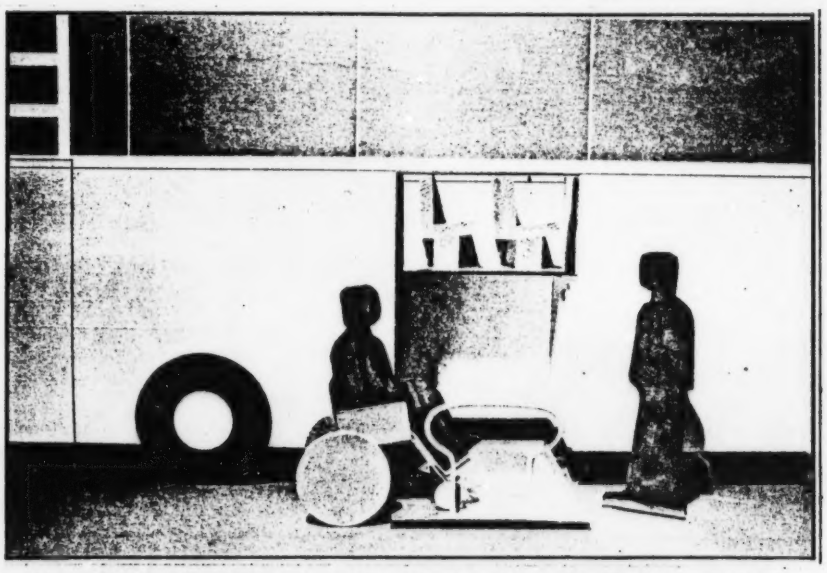


Fig. 33 Wheelchair user accessing platform unaided.

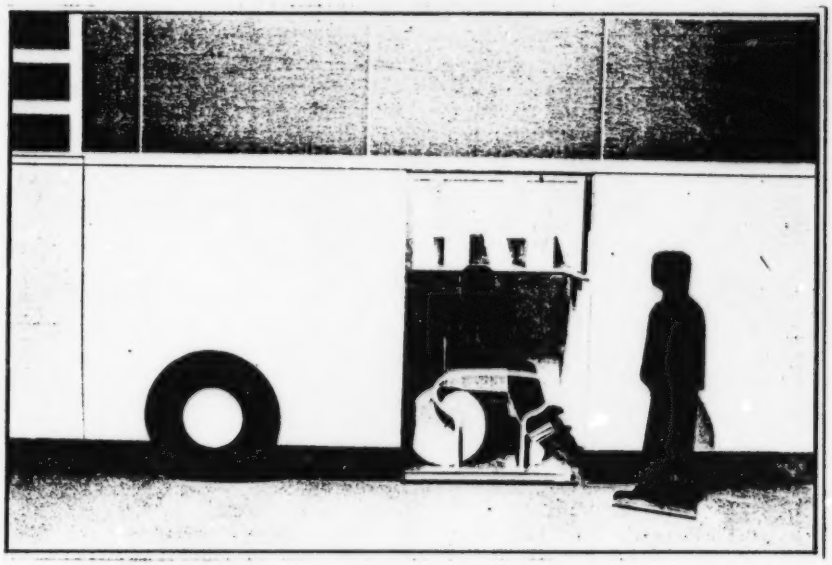


Fig. 34 Passenger in wheelchair ready to ascend with elevator. Attendant controlling elevator.

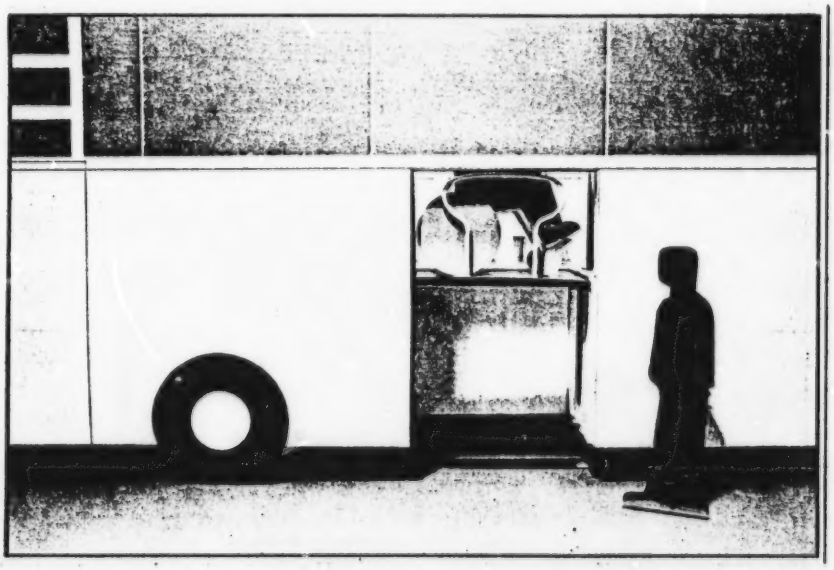


Fig. 35 Elevator at floor level. Wheelchair user ready to manoeuver into travelling (tie-down) position.

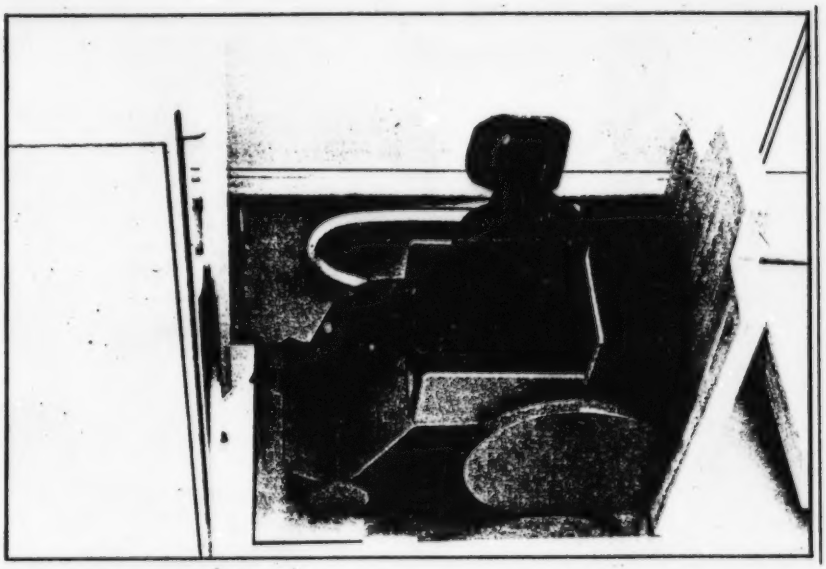


Fig. 36 Wheelchair passenger restrained against tie-down system with wheelchair resting on elevator platform.

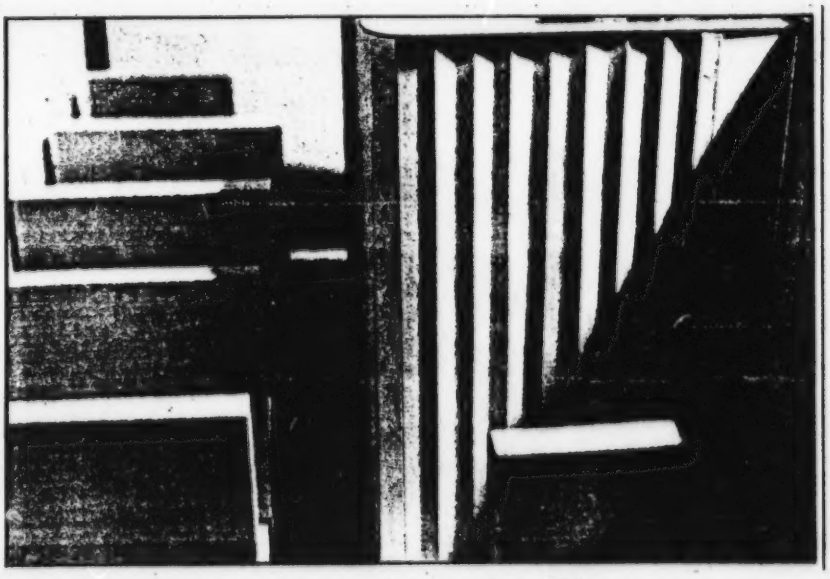


Fig. 37 View from rear showing flexible screen enclosing wheelchair passenger and tie-down in transfer space while passenger accesses washroom.

Fig. 38 Attendant using elevator platform to move catering carts to bus floor.

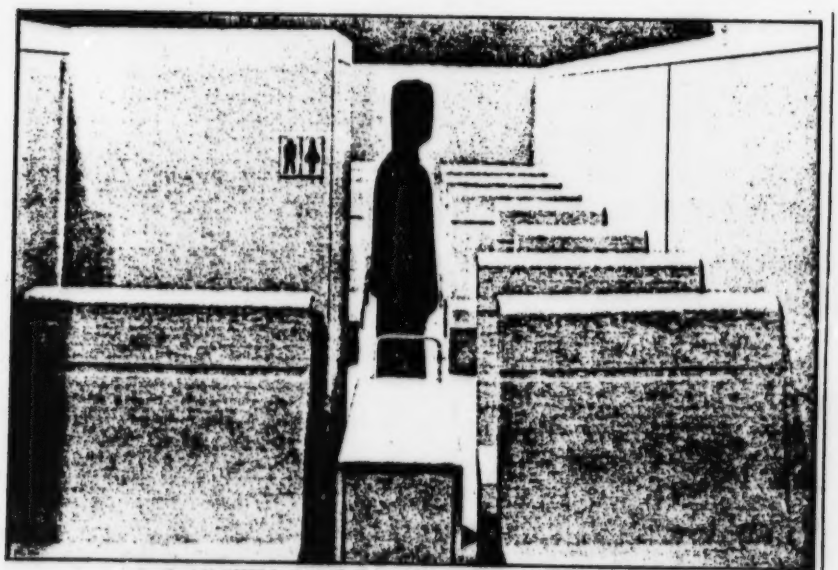


Fig. 39 Catering carts being taken down bus aisle by attendant.

3.5 Installation

Our close cooperation with Prévost engineers has enabled the design and its implementation to be such that very little of the existing bus structure is disturbed, once more the rear entry/exit has been maintained.

Structural modifications as necessary to accommodate the proposed lift system, washroom, privacy screen, tie-down and special seating cannot be defined in full detail at this stage. A preliminary drawing # 1082/4, with the title; Facility Component Design (see appendix) illustrates suggested design and some details related to accessibility design for the Prévost articulated bus. The washroom design, privacy screen, elevator, tie-down and special seating (where applicable) have to be developed further in order to test and evaluate the concept in conjunction with the special need traveller, manufacturer, mechanical and transport engineers.

Without this further development (user/fabricator feedback) resulting in refined designs, it is not appropriate, at this time to assess the cost factor involved in the proposed solution.

Douglas Ball Inc. has analyzed the capability of such a concept being built and we feel that the manufacturing expense would be comparable to the fabrication of a molded, fibreglass washroom, as has been done at Prévost to date, and the fabrication and installation of the types of elevators presently manufactured. These have been previously discussed and found to be unsuitable for this particular application.

The tie-down concept has been developed and tested and the principal idea needs to be adapted to the articulated bus. The initial development work has virtually been completed (ref. TDC project TP 3057E). Douglas Ball Inc., in the capacity of design consultant with numerous innovations to its credit, would be able to eliminate much unnecessary expenditures using available manufacturing and engineering resources in order to develop and produce the final solution for articulated bus accessibility.

At present there is no suitable elevating device, washroom or tie-down system capable of providing for the requirements of the special need travellers (in particular the wheelchair users) either in Europe or North America.

Even with regard to the Neoplan articulated bus of German Design (in particular the Highliner N 120: 18000 x 2500 x 3550 mm with capacity of 77 persons which resembles the Prévost bus) there is no provision of elevating device or accessible washroom and restraint system for the special need traveller. The principal of the vertical elevator as found in conventional European models was illustrated earlier. One, of course, was not suitable for a wheelchair but this principal is one which we feel appropriate to the requirements of the special need travellers as applied to the articulated bus design.

3.6 Application of component 'package'

It has been suggested that because of the innovations in the design concept, even at this early stage, the sound ideas which have evolved through working closely with Prévost Car Inc. and TDC, and with the understanding of the requirements for the special need passenger, that this component 'package' could be applied to other types of buses and possibly other modes of transport.

Use of rear section

With further consideration of this 'package' principal, which in fact had been brought up in early communication with Prévost, the entire rear section should be considered as a feature which, being flexible, can be easily changed to meet the needs of different clients. Such a device as a built-in elevator would assist in providing an effortless loading aid when the interior layout is required to be changed periodically (e.g. using the elevator, seats can be removed in order to make more room for communication equipment, tie-downs, exhibition material, etc.).

The modular washroom would be a permanent feature, as required, for the needs of the carrier and because of the compact design would not intrude much into the floor area. Additional services would generate from this facility 'package'.

Interior layout 'package' meeting different requirements would be of interest to markets other than the special needs.

Potential uses for such a flexible interior with elevator, folding screen and modular washroom incorporated are as a:

- communication unit
- computer centre
- forensic laboratory

- private stretcher enclosure and mobile hospital
- film lab, dark room, x-ray facility
- sportscasting centre for outdoor events
- exhibition space, audio/visual projection unit for internal/external presentations
- soundproofed recording studio
- ventilated washroom/kitchen space as applied to conversion to a mobile dwelling

Examples of possible applications are shown in Fig. 40 and 41

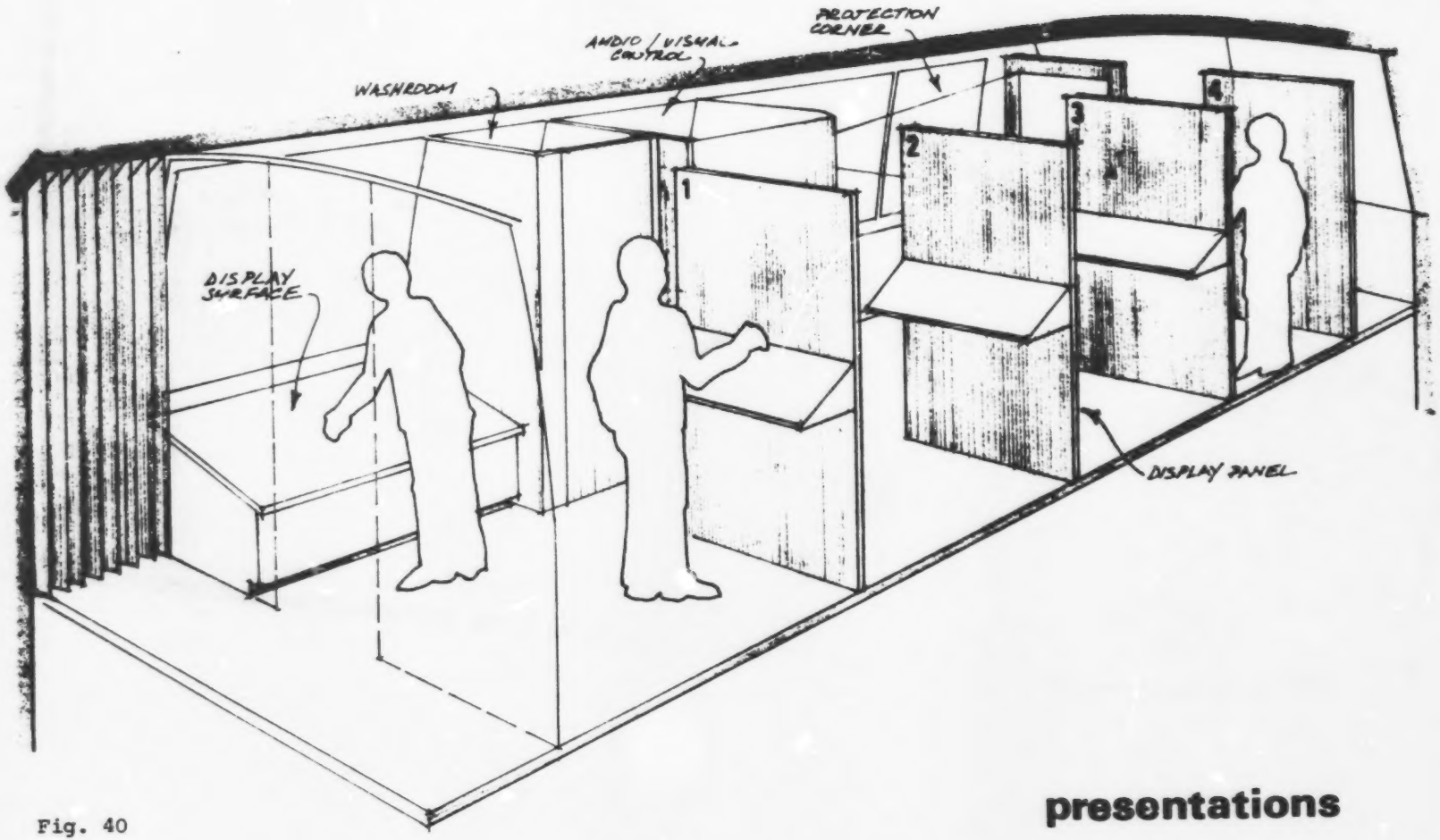


Fig. 40

presentations

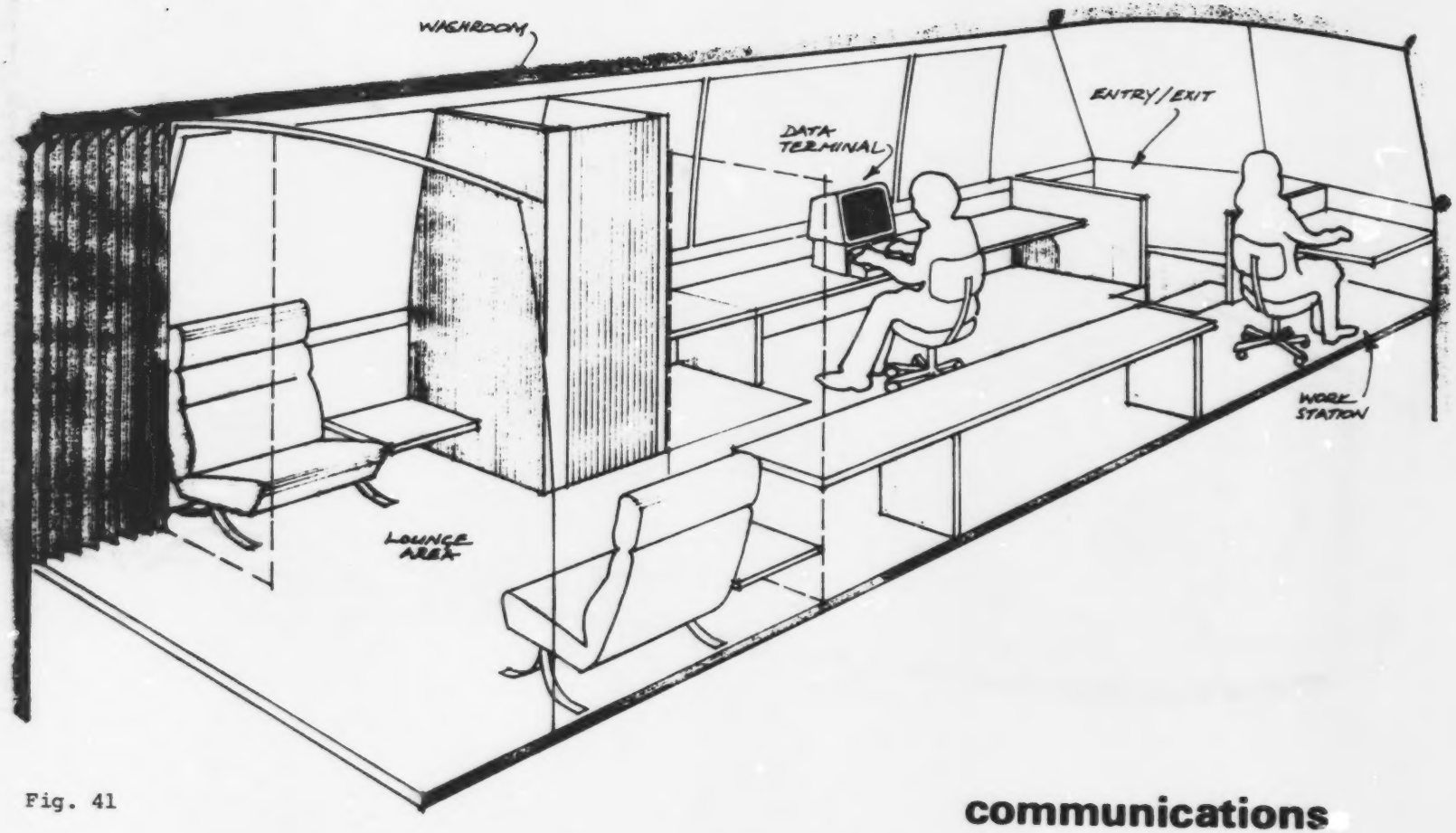


Fig. 41

communications

4. RESULTS

Prévost Car Inc., the Transportation Development Centre, the consulting ergonomist and representative for the special need travellers have shown a favourable response to the final design concept.

The model, showing the concept and its variations in a comprehensible form, has stimulated a number of new developments which we feel are necessary and worth mentioning at this point in order to bring the design up to form.

Suggestions for improvements to the proposed design (Concept C) that have come out of the final presentation of the model, the drawing and the resulting assessment by all parties involved have strengthened the viability of the design concept as presented here by Douglas Ball Inc.. These refinements to the concept should be seriously considered as part of the next phase of this project. These are outlined below:

- Provision of a jump-seat into/near each tie-down assembly, to be used by semi-ambulatory if wheelchair not required.

- Storage and deployment of folding screen could be done in one operation using only one screen (providing access to washroom and enclosure of transfer space simultaneously).

- A standard folding wheelchair to be a permanent part of the on board 'kit' to assist the special need travellers.

As mentioned at the beginning of this report, no definitive standards can be found that relate particularly to the accessibility, handling and safe carriage of special need passengers on inter-city buses in Canada.

This project, in part, has laid the basis for an understanding of this problem. Further development of the proposal, as presented by Douglas Ball Inc., will undoubtedly provide support to the idea of the articulated bus as a viable transportation concept for this country and, would simultaneously help to establish the standards

of accessibility, comfort and safety for all passengers.

An important aspect of this development is the safety of all passengers, in particular those in wheelchairs and those other travellers who are not able to provide the quick response which is required in emergency situations.

Emergency exits either through rear doors, windows or removable roof panels (especially over wheelchair positions and large enough for wheelchair and passenger) are an important aspect of any bus design. These necessary precautions have not been outlined in detail at this point but would need to be defined more extensively as part of the next stage in accessibility design for the articulated bus.

The consideration of disabled people as part of the 'normal' population is a growing trend among the general public as well as architects and designers. This is firstly due to an increasing realization that the lack of certain abilities in no way affects one's remaining abilities. Secondly, the awareness that, if incorporated at the outset in architectural, product or transport design, the extra expense of providing for most disabled people is an insignificant part of the total cost. The proportion of elderly or disabled population is constantly increasing. With the present age distribution and improvements in medical science, it is estimated that, in twenty-five years, one quarter of the population will be over fifty years old. While the requirements outlined in this report may appear stringent, none of them is prohibitively expensive, and for an increasing segment of the population they are necessary to provide a level of comfort and security most of us take for granted.

5. RECOMMENDATIONS

It is felt that this design concept for the access of special need travellers, as proposed by Douglas Ball Inc., can only be further evaluated by the building of a functional prototype to be tested in the articulated bus by representatives of special need groups. Only in this way can the proposed design be fully refined as requirements of the user, operator and manufacturer are analyzed and assessed with the aid of a full-size working prototype. This concept includes the modular washroom, privacy screen elevator, tie-down system and appropriate seating as required by the special need passengers.

Prévost Car Inc. has been asked to study the possibility of incorporating a functional prototype of this concept into its first articulated bus in order to show it to potential customers and to present it at Expo '86 in Vancouver.

A workplan for the next phase is included on the following page.

Phase II Workplan

1. Prepare detailed workplan, budget and schedule.

2. Prepare working drawings for prototype construction.

3. Prepare system component specification.

4. Build a functional prototype of elevating system, complete with tie-down, washroom, folding screen and special seating.

5. Perform functional test of system components in-house.

6. Make the prototype unit available to Prévost Car Inc. and/or Transport Canada for purpose of field tests.

7. Monitor and support testing (repairs, modifications, etc.).

8. Report and evaluate test results.

9. Implement necessary design changes and produce final manufacturing drawings and specifications.

10. Document the project in a report complete with illustrations, photographs and drawings.

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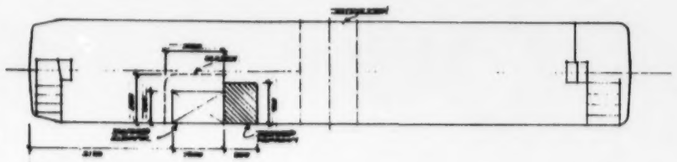
APPENDIX

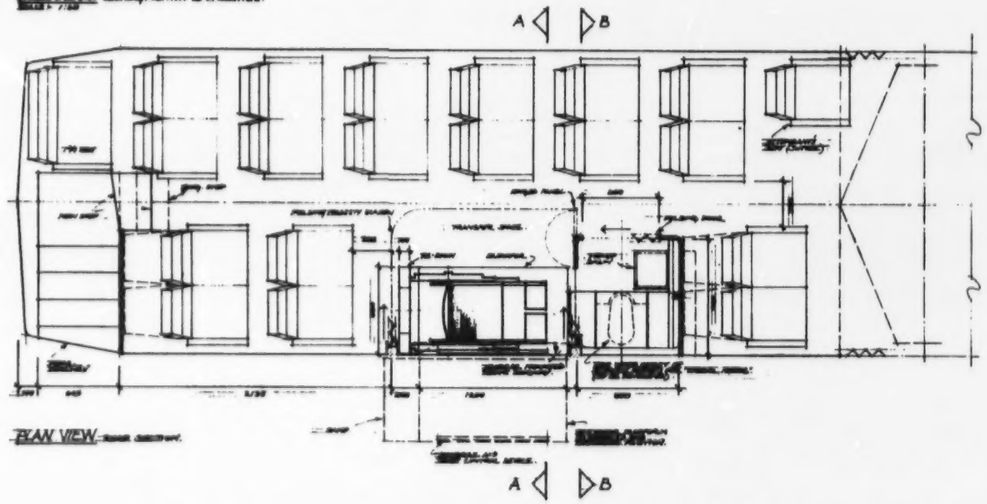
Component Design Drawing (Concept C)

Concept Analyses

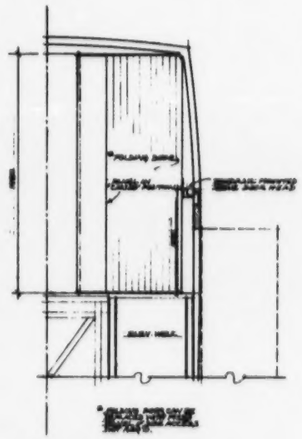
PRELIMINARY ONLY
NOT FOR PRODUCTION



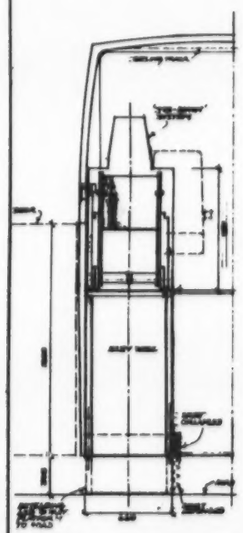
FULL PLAN



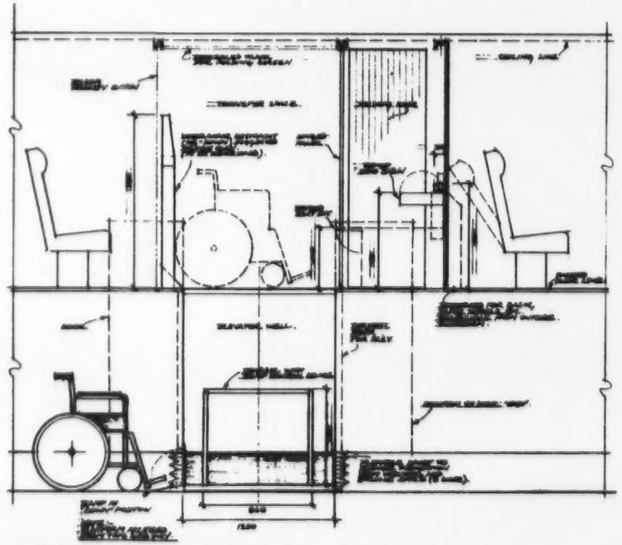
PLAN VIEW



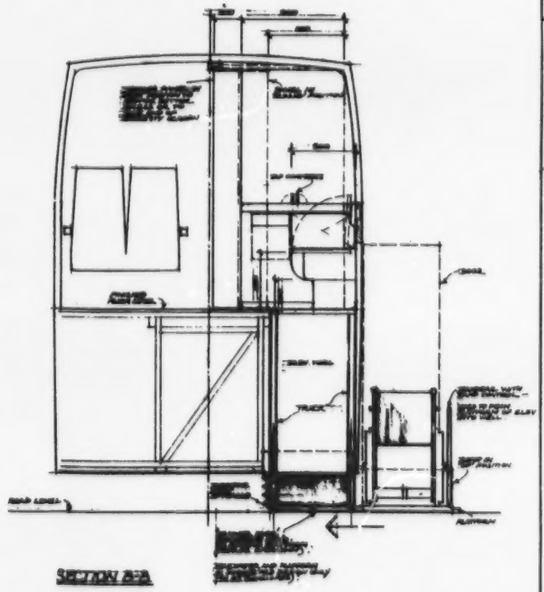
SECTION B-B



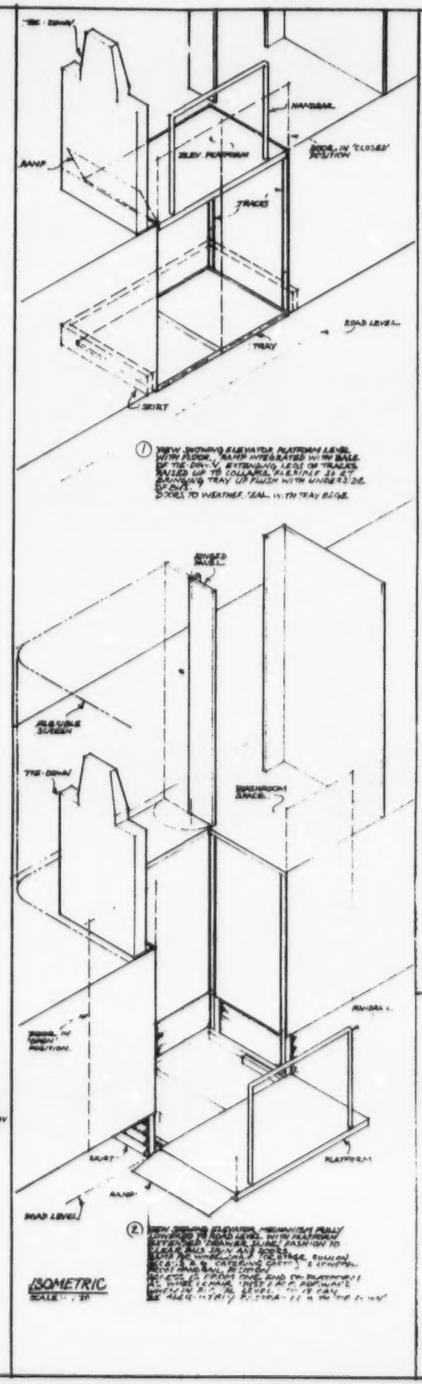
SECTION A-A



ELEVATION



SECTION B-B



ISOMETRIC

NOTES:

LBS DESIGNERS
DOUGLAS BALL INC.

Project/Projet
WASHROOM, SEATING, ACCESS
DESIGN FOR PREVOST CAR, INC.

Description/Nature of Drawing
FACILITY COMPONENT DESIGN
(CONCEPT 'C' (FLEY, TIE-DOWN,
MODULAR WASHROOM & SCREEN)

Design par/Designed by
U. RUTENBERG, M. BARBER

Drawn par/Drawn by
M.B.

Scale/Echelle
1:20 (METRIC)

Date
7 JAN 1985

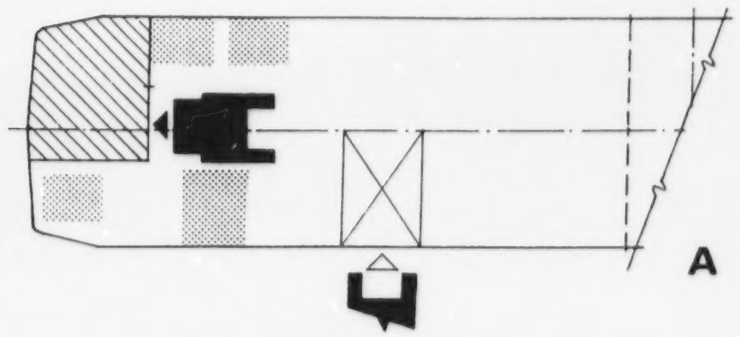
N° de dessin/No. of drawing
PC 1082/4

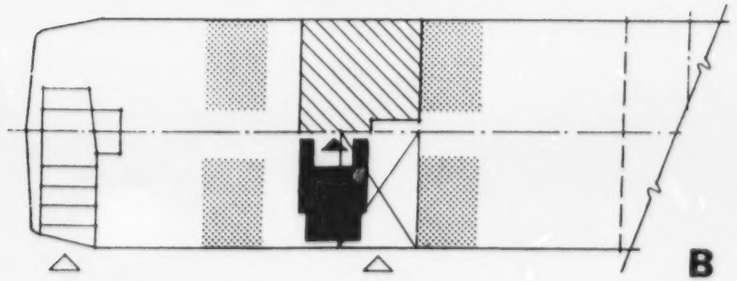
concept C

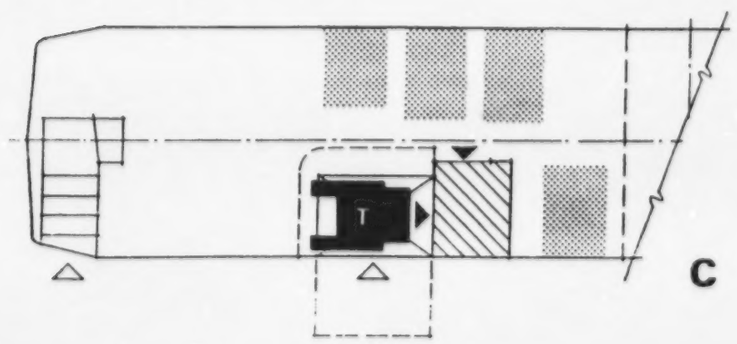
Concept Analysis

Viewpoint of Manufacturer

W/c - wheelchair
O - others





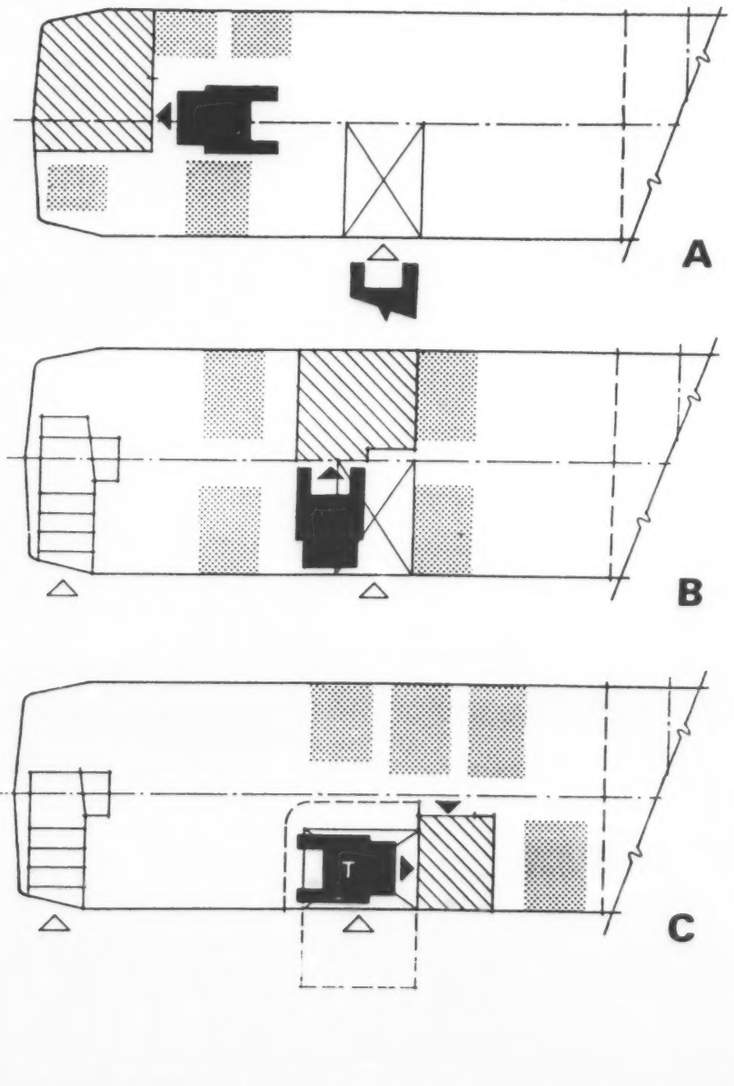


STRUCTURAL MODIFICATIONS	ADDITIONAL MODIFICATIONS	WASHROOM DESIGN	SEAT LOSS (original design, standard washroom, 28 seats in rear section)	EVALUATION OF CONCEPT
Design of elevator affects main structural members of bus.	New door opening for elevator. New washroom at floor level (rear). Original rear door and steps not utilized.	WC: Design accommodates wc manoeuvering 360° and attendant. O: Additional space might be problem for semi-ambulatory & elderly when bus in motion.	10	Elevator position cuts into structure. Major structural modifications necessary. Alterations take place on different sides of vehicle. No rear entry/exit eliminated.
Same	New door opening for elevator. New washroom at floor level (centre) opposite elevator.	WC: Design accommodates wheelchair - either front or rear access. O: Space good for special need and regular passenger.	7	Elevator position cuts into structure. Washroom position such that modifications opposite each other. Bus centre occupied with washroom & elevator, washroom reduced in size; elements possibly cheaper to fabricate. Rear entry/exit retained.
Design does not affect main structure. All modifications take place in same area of structure.	New double door opening for elevator. New modular washroom at floor level.	WC: Washroom not required to accommodate full wc. Screened transfer space used. Transfer L/R. O: Wide aisle door good for all. Compact design aids in stability of passengers.	7½ 3½ (when tie-down space occupied with double standard seat)	Elevator position changed to reduce structural modifications. Washroom reduced in size and adjacent to elevator. All modifications/fabrication can be done on one side in same area. Rear exit retained.

Concept Analysis

Viewpoint of Operator

Wc - wheelchair
O - others

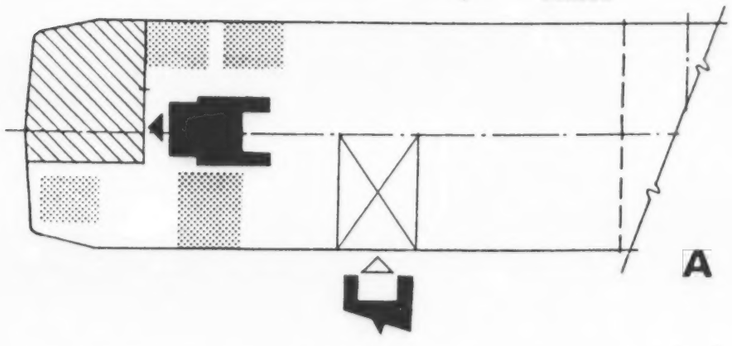


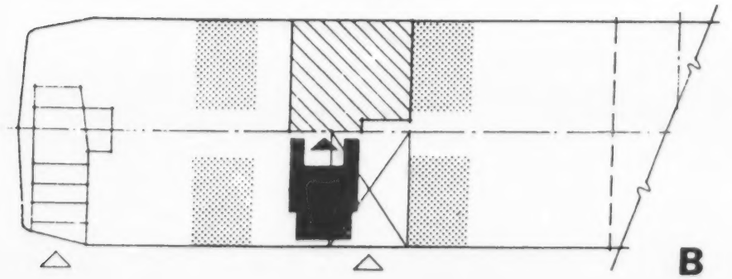
DOOR OPERATION	ELEVATOR OPERATION	BOARDING/DEBOARDING ASSISTANCE	ASSISTANCE WITH RESTRAINT	ASSISTANCE TO WASHROOM
Automatic door 'open' and 'close' mechanism operated from outside and inside of bus.	Automatic remote control system available for operator. Positive manual lock of platform when level with bus floor.	Should always be available. Suggest 2 for 1 policy for special need travellers with companion (attendant).	Manual system. Design should allow for ease of use by most travellers with manual dexterity.	WC: Distance from tie-down considerable. Assistance required when bus in motion. O: Seat located near washroom. Assistance not required for most passengers.
Same	Same	Same	Same	WC: Distance from tie-down minimal. No space inside for attendant. O: Special seating near washroom, assistance not required for most passengers.
Same	Same	Same	Same	**WC:** **Chair remains in tie-down; passenger access through folding side door. Handrail used. Transfer possible when in motion. Assistance not always required.** O: Special seat opposite wide aisle door.

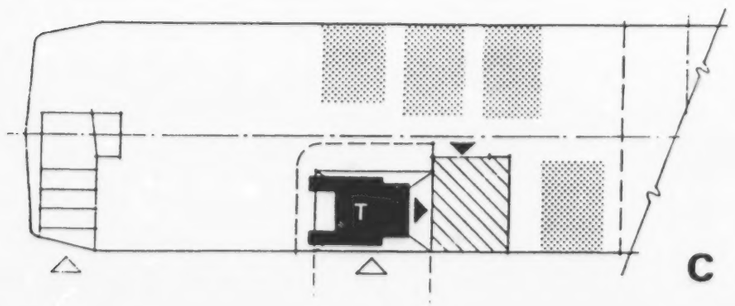
Concept Analysis

Viewpoint of passenger

Wc - wheelchair
O - others







MAIN ACCESS ELEVATOR USE	ACCESS TO TIE-DOWN/ ACCESS TO SEAT	TIE-DOWN/SEAT SAFETY AND COMFORT	ACCESS TO AND USE OF WASHROOM	EVALUATION OF CONCEPT
WC: Automatic doors, roll chair onto elevator platform backwards to ensure head clearance. O: Jump-seat on platform so passenger can stand and hold onto safety rail. Elevator height adjusts to curb/road/ other level.	WC: Some manoeuvering required as tie-down perpendicular to elevator. O: Special seats accessible but at some distance from elevator. Isolate rear section when in use.	WC: Must release tie-down to go to washroom.	WC: Considerable manoeuvering distance, not recommended when in motion. Attendant a must. O: Can be accessed quite easily. Large space might create problems for semi-ambulatory.	No steps, no rear exit in emergency. Deep ramp required to cover gap (platform to curb). No room for stretcher. Must release tie-down to access washroom. Manoeuvering distance considerable to wc.
Same	Same O: Special seats near elevator.	WC: Must release the tie-down to go to washroom. O: Insufficient support for semi-ambulatory/ elderly/people with manipulation problems.	WC: Distance to washroom reduced, less manoeuvering space inside. O: Special seats near washroom. No room for attendant if required.	Must access washroom backwards if lateral transfer (left) required. No room for stretcher. No room for attendant. Wc manoeuvering required.
WC: Automatic doors, sliding platform provides front access minimum manoeuvering. O: Elevator platform can be access without being extended. Jump-seat for semi-ambulatory.	WC: Tie-down immediately behind elevator - no manoeuvering required. O: Semi-ambulant can find special seats opposite elevator. Elevator does not isolate rear section when in use.	WC: Wheelchair restrained througbout journey.	WC: Can access from wc if able, using handrail. Full screen encloses tie-down. O: Access through wide aisle door. Small size good for those with stability problem.	**Screen enclosure provides room for attendant plus 4 access positions for wc.** **Room for stretcher. 2 wide doors to washroom wc access min. space.** **No manoeuvering required while wc tied-down. Special seat adjacent to washroom.**